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ARMED FORCES CHEMICAL JOURNAL

OFFICIAL PUBLICATION OF THE ARMED FORCES CHEMICAL ASSOCIATION

SUITE 819, 2025 EYE STREET, N.W., WASHINGTON 6, D.C.

VOLUME X JANUARY-FEBRUARY 1956 NO. 1

COVER PHOTO

Color chemistry working at the foot of Fujiyama. This picture of variously hued smoke grenades burning against the background of the famous mountain, suggestive of an old Japanese print, was snapped during training exercises in that area, some time back, of an U. S. Army division.

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Published bi-monthly—Jan.-Feb.; Mar.-Apr.; May-June; Jul.-Aug.; Sept.-Oct.; Nov.-Dec.—by the Armed Forces Chemical Association, located at National Headquarters, Armed Forces Chemical Association, Suite 819, 2025 Eye St., N. W., Washington 6, D. C. Entered as second class matter at the Post Office at Washington, D. C., under the Act of March 3, 1879. Additional entry at Nashville, Tenn. Subscription price $2.00 per year to members; $4.00 per year to non-members. Inquiries concerning circulation and advertising should be addressed to the Secretary-Treasurer.

FAMOUS "BLUE ANGELS" ON NAVY PROGRAM FOR A. F. C. A. MEETING

In a last minute flash before press time, Chairman Wansker informed the JOURNAL that the Navy's operational exercises program for A.F.C.A. on June 15 will include a squadron of four destroyers as well as the carrier, USS *Antietam*, and will involve extensive naval gunfire in addition to naval aircraft operations.

The plan is to make the day at sea an A.F.C.A. "father and son" program. The A.F.C.A. group on the carrier will be limited to 300 male members. Boys 14 years of age and above, sponsored by members attending, will be taken aboard destroyers, the total number not to exceed 160.

In view of the extraordinary opportunity this program affords and the limitation on the number of members who can be accommodated, reservations for the cruise will be made in the order received. Letters should be sent to Chairman Wansker or Col. Salmon, treasurer (see committee listing herein); for further details see March-April issue.

It has further become evident to the Committee that in order for the attending members to take full advantage of the unique program which the Navy is providing, the entire day-time period of June 15 should be devoted to that schedule. This precludes the holding of any business sessions while the A.F.C.A. group is aboard the carrier and has necessitated a major revision in the previously planned schedule for June 14. Therefore, it has been decided that the program for June 14 will consist of registration, Board of Directors meetings, and the general meeting of the Association during the forenoon at A.F.C.A. meeting headquarters, Hotel Somerset; the afternoon to be devoted to the symposium. For this there will be talks by outstanding speakers on matters of current scientific importance and interest to the Association. At least one of these talks will bear upon the forthcoming world-wide program for 1957-58 which has been designated the International Geophysical Year.

—Official U. S. Navy Photograph

WHEELS, FLAPS AND DIVE BRAKES DOWN, the U. S. Navy's famed Flight Demonstration Team, BLUE ANGELS, make a simulated carrier pass at near stalling speed to demonstrate the slow flying characteristics of the new swept-wing Grumman F9F-8 "Cougar" jet. During the other maneuvers performed by the BLUE ANGELS, the precision flight team reaches speeds approaching the sonic barrier while flying with their wing tips a scant five feet apart.

THE U. S. NAVY's famed BLUE ANGELS, jet fighter aircraft flight, renowned for breath-taking demonstrations throughout the country of precision tactical techniques at sound-barrier speeds, is to participate in the June 15 program being planned by the Navy for A.F.C.A.'s eleventh annual meeting in the Boston area June 14-15.

This is one of two new developments in the planning for the June 15 schedule of events to be provided for by the Navy as the Host Service for the 1956 gathering.

Information of this addition to the program was given the JOURNAL shortly before press time for this issue by Commander Thomas Quillman, of the Navy's Office of Information, Washington, D.C.

Meanwhile, Mr. Harry A. Wansker, chairman of the Arrangements Committee for the meeting and vice-president of A.F.C.A. had informed Association Headquarters of another significant development. This is a change in the aircraft carrier earmarked for the cruise and exercise at sea starting from the Naval Air Station at Quonset Point, R. I. Instead of the *USS Tarawa*, as announced in the last issue of the JOURNAL, the Navy has decided to provide the even larger and more modern carrier, the *USS Antietam*. This ship, completed toward the close of World War II, participated extensively in the Korean operations. A style-setter in aircraft design, the *Antietam* is the world's first carrier constructed with a so-called "canted" flight-deck, providing two aircraft runways at an angle to each other so as to make possible simultaneous take-offs and landings. This design promotes safety and gives greater flexibility in operational use of the ship.

The BLUE ANGELS part of the program will be operated from the Naval Air Station at Quonset Point, R. I. To give the Navy adequate time for the series of memorable events it plans to provide, it will probably be necessary to start the day of June 15 somewhat earlier than now scheduled by stepping up the departure from Boston to 6:00 A.M. or thereabout.

Further details concerning the Navy's participation, as well as other phases of the program, will be given in the March-April issue.

With respect to the schedule as it now stands it should be noted that while the ladies may not go aboard the carrier for the cruise, an interesting program for them at the Quonset air station is being provided for.

Although the meeting is still five months away, Chairman Wansker urges early reservation of hotel accommodations.

The program for the ladies on June 14 provides for two alternative visits:

1. (Limited to 100) House of Seven Gables (Salem, Mass.); lunch at Corinthian Yacht Club (Marblehead, Mass.); and visit to historic Gloucester.

2. Visit to John Alden House (Duxbury, Mass.); luncheon at Toll House (Whitman, Mass.); return via Plymouth Rock (Plymouth, Mass.)

Since the last announcement a number of additions have been made in the committee on arrangements. The new listing by subcommittee assignments is as follows:

ARMED FORCES CHEMICAL ASSOCIATION ANNUAL MEETING JUNE 14-15, 1956 COMMITTEE ASSIGNMENTS

1. **GENERAL CHAIRMAN**
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Whitfield Reid, Vice Chairman; Lawyer, Boston, Mass.

5. **CONVENTION HEADQUARTERS COMMITTEE**
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Arthur G. Boardman, Vice Chairman; Agent, Mutual Benefit Life Insurance Co., Boston, Mass.

6. **REGISTRATION**
Thomas D. Adams, Chairman; Production Dept. Manager, Firestone Industrial Products Co., Fall River, Mass.
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7. **MEN'S GENERAL PROGRAMS, JUNE 14-15**
Harry A. Wansker, Chairman; Director of Government Relations, United-Carr Fastener Corporation, Cambridge, Mass.
Brig. Gen. James F. McManmon, USAFR (Ret.), Vice Chairman; Chairman of the Board, Harrington & Richardson, Inc., Worcester, Mass.

8. **MEN'S SPECIAL M.I.T. PANEL, JUNE 14**
Dr. Harold C. Weber, Chairman; Professor of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.
James Donovan, Vice Chairman; Treasurer, Artisan Metal Products, Inc., Watertown, Mass.

9. **BABSON PROGRAM, JUNE 14**
Dr. E. B. Hinckley, Host Chairman; President, Babson Institute of Business Administration, Wellesley, Mass.
Lawrence J. Meyns, Vice Chairman; Chairman, Div. of Management & Production, Babson Institute of Business Administration, Wellesley, Mass.

10. **A.F.C.A. DIRECTORS MEETING**
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Charles B. Weeks, Chairman; Treasurer, Hesse-Eastern Division, Flightex Fabrics, Inc., Cambridge, Mass.
Chenery Salmon, Vice Chairman; Vice President, Merchants National Bank, Boston, Mass.

11. **LADIES PROGRAMS, JUNE 14-15**
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12. **TRANSPORTATION COMMITTEE**
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13. **BUDDIE PROGRAM**
To be announced later.

14. **PUBLICITY**
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15. **BANQUET-RECEPTION, JUNE 15**
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Fred C. Cummings, Public Information Officer, Boston Naval Shipyard, Boston, Mass.
Justin N. Kirk, Chief, Research Services Office, QM Research & Development Center, U.S.A., Natick, Mass.
Col. Raymond A. Guzicki, TC, Transportation Officer, Army Base, Boston, Mass.
Major D. L. Furches, Cml. C. Reserve, Massachusetts Institute of Technology, Cambridge, Mass.
Maj. Lawrence B. Krogh, USAF, Information Service Officer, Hq. Air Force, Cambridge Research Center, Bedford, Mass.
Joseph N. Casey, Public Information Office, Corps of Engineers, Boston, Mass.

21. **HIGH SCHOOL—TEACHER PROGRAM COMMITTEE**
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Howard P. Richardson, Vice Chairman; Vice President, First of Boston Corporation, Boston, Mass.

FREEDOM'S NEED FOR THE TRAINED MAN

LEWIS L. STRAUSS

". . . ourselves and children have lost, or do not learn for want of time, the sciences that should become our country."

[Shakespeare, *Henry V*]

Following is a condensation of the address titled as above presented to the Sixth Thomas Alva Edison Foundation Institute, West Orange, N. J., on November 21, 1955, by

LEWIS L. STRAUSS

Chairman of the U. S. Atomic Energy Commission

Admiral Strauss, whose views on the subject of promoting secondary school education in science and mathematics appear to parallel closely those of A.F.C.A., here proposes two measures as possible solutions of this national problem.

IF THERE IS TO BE another war among the great nations of the world before the human race discovers a method of abolishing recourse to combat, that war may be survived by the country with the greatest stockpile of nuclear weapons and instruments of their delivery. But such a war will almost certainly be lost by the country with the fewest resources in trained manpower.

This is a conclusion which has been reinforced for me by experiences during the past fifteen years, first with the research activities of the Navy and later with the Atomic Energy Commission. In the latter area, there are three components necessary to success in meeting our established objectives. These are, first, the elemental raw material; second, the required funds, and third, human skill and intelligence.

Early in the work of the Commission, it looked as though the raw material (uranium) would be a limiting factor. . . . By setting incentive prices which vigorously stimulated exploration and prospecting . . . we have stepped up the production of this vital material to a point literally undreamed of ten years ago.

The second requirement—money—has never been denied to the enterprise by the Congress. . . .

The third and indispensable component of success obviously is gray matter. Here, also, we have been fortunate, until now. But while we can look ahead and see no indications of dearth in raw material or means, the prospect for trained minds is a very different and gloomy one . . . men and women cannot be qualified in discipline so exacting as modern science without a dedicatory period—an apprenticeship—of years. . . .

THE RECENT CONFERENCE in Geneva on the Peaceful uses of Atomic Energy produced a number of notable results . . . it was the greatest scientific gathering ever convened. Some of these results already are evident; others will materialize as new inventions and refinements in many facets of the nuclear art bear fruit from the cross-fertilization of Geneva.

An immediate result was that we learned much about the quality of Soviet science. . . . And what we learned was sufficient to shatter any complacency we may have enjoyed in regard to our own imagination and ability. Too many of us have fallen into the easy attitude of assuming that the Russians . . . could never match us in scientific initiative and progress.

This was dangerous self-delusion. Actually, the emphasis which the Soviets are placing on science and particularly on the training of new young scientists and engineers, presents a real and growing challenge to us, and to the free world.

Today their technical schools and universities are turning out scientists and engineers who are well-trained and highly competent. Since Geneva we know this. The quality may differ from field to field, but generally speaking, their first-rank men appear to be as good as our own.

The Soviet challenge is not one of technological quality so much as of numbers. It is evident that we are rapidly falling behind Soviet Russia in the training of engineers and scientists. The level of our reservoir of trained brainpower is dropping, in relation to the demand. They, on the other hand, are striving to fill theirs to capacity as rapidly as they can.

The facts and figures speak for themselves and they are not pleasant facts and figures. I should say here that their absolute accuracy cannot be assured, which is the case with most data from the dark side of the Iron Curtain, but they deserve and demand the prompt attention of everyone who is interested in the continuation of our prosperity and in preserving our security and in maintaining peace.

WE DO KNOW with certainty that we are turning out less than one-half the number of scientists and engineers we require—an alarming statistic by itself. . . .

Inevitably our shortage of scientific manpower will be-

come worse before we can do anything to correct it. This is an inescapable fact.

At present, we are about even with, or perhaps slightly ahead of the Soviets in numbers of trained scientists and engineers—about one million in each country and, in Russia's case, for an industrial establishment far smaller than ours. . . .

We require from 45,000 to 50,000 new trained engineers every year. We are getting half that number . . . June's crop was around 23,000. Russia . . . is graduating 120,000 new scientists and engineers of all types this year, which compares with out total of 70,000 graduates. Between 1950 and 1960, which may be the most critical decade of our national existence, Russia is expected to produce 1,200,000 trained engineers and scientists, against our 900,000 . . . the sciences have an over-riding priority in Russian education. More than half of all Russian university graduates are in the science-mathematics fields; only one-fifth of our graduates are in those fields. Russian Ph.D.'s, or the equivalent, are three to one in favor of science and engineering; in the United States the ratio is just the reverse—nearly three doctorates in the humanities for every one in science and mathematics.

Where is the answer to this challenge to be found? . . . The trouble does not rest, I think, at the end of the line of training, that is to say in our colleges and universities. They cannot create the candidates for these posts without the human material to start with. The difficulty lies *more deeply in our educational system*. Our graduate institutions cannot supply the scientists and engineers we need, if students do not come to them, ambitious to be scientists and engineers and possessed of *adequate high school preparation* for such careers. The decisions that produce our skilled scientists and technicians are made, in the main, before they arrive on the college campus.

Only about 16 per cent of the high school graduates entering college last year enrolled in engineering courses —or about 66,000 of them. . . . More than half of these 66,000 young hopefuls will flunk out along the way, or switch to other, easier courses. Ask the deans of our engineering schools for the reason and a composite of their answer is:—"poor high school preparation in science and mathematics."

OUR HIGH SCHOOL systems—or, to be more accurate—you and I—are failing in our obligation to our national welfare and security. We fail when we squander the most valuable of our natural resources. Our youth is not being exposed to the excitement and challenge of science. We are not equipping the growing generation to protect or even to fully enjoy their modern heritage.

Large numbers of our high school students have no opportunity to discover whether science and engineering appeals to them, because preparatory courses are not available, or—when such courses do exist—they often are taught by instructors who double in science, but whose interests lie in other subjects.

A recent survey indicates that from 250,000 to 400,000 high school students in our country presently are learning mathematics from teachers not trained to teach it, and the same situation prevails in science teaching. . . .

Since there are not enough trained teachers to go around, the alternative becomes one of using unqualified teachers, or abandoning those courses. In an appalling percentage of instances . . . the courses have been abandoned.

The problem becomes a chain reaction in reverse. . . .

A graduate scientist or engineer cannot reasonably be expected to choose a teaching career at a salary so low that he may be compelled to take an after-hours job, often of a menial nature, to even make ends meet . . . when he has the option of a number of better paying jobs elsewhere. . . .

Our high school enrollments are growing but there are fewer college graduates to teach them. The number of qualified teachers of science and mathematics has fallen off about 53 per cent in the past five years. . . . [This] figure . . . in reality, is a sugar-coated one, because not more than half of the men and women who leave college qualified to teach those subjects ever find their way into a high school classroom. For example, of the 1954 college graduates qualified to teach chemistry, about 36 per cent actually did so. . . .

One needs no more than these few statistics to see that our supply of scientific and technical manpower is withering at its source—in the high schools—for want of nourishment, while the Soviets assiduously cultivate ever-larger numbers at that same level.

IN RUSSIAN HIGH SCHOOLS, of the study courses which every student must take, 40 per cent are in science and mathematics. I am told, furthermore, that young Ivan is made to work much harder than our Johnny; he goes to school six days a week and by the time he completes high school he has had six years of biology, five years of physics, four years of chemistry, and four years of mathematics, including trigonometry. . . .

If this were not sad enough, more than half (53 per cent) of our high schools do not teach physics at all. . . .

Half of our high schools do not teach chemistry.

Two generations ago, in 1890, one in every five high school students studied physics. Today it is only one out of every 22. More than half of all students back in those days studied algebra; now it is less than one-fourth. The study of chemistry has fallen off 30 per cent. These are the statitstics of the United States in the era of technology.

Let us look briefly at the situation that prevails in these high schools still struggling to maintain science and math courses.

A survey of 30 states showed that about 1,800 new mathematics teachers were urgently needed, but 700 of the positions had to be filled with unqualified persons. . . .

I sincerely hope that none of my remarks will be regarded by anyone as reflecting upon our high school teachers. They are devoted, underpaid and self-sacrificing people and we have too long taken advantage of their devotion. If the teacher of music, or the high school athletic instructor, is required to teach chemistry or mathematics because no qualified instructor can be obtained, the blame should attach to us, for allowing our educational system to fall into such a regrettable state.

Also, I have dwelt on the contrasts in our educational program and its result with that of Soviet Russia, but not in any sense to suggest that what the Soviets are doing contains a solution to our problem. Their system of regimentation and even enslavement of the individual as a pawn of the state is repugnant to us. Our solution will have to be an American solution, consonant with our traditions of freedom and the dignity of the individual.

FIRST OF ALL, we must in some manner insure that those students with demonstrated aptitudes receive the inspiration they deserve. This is a challenge to parents, educators, industry, professional societies and for Government at the federal, state and local levels. It should be a matter of national remorse that less than half of our brightest school students—those in the top

(Continued on page 15)

SELECTIVE SERVICE AND SCIENTIFIC MANPOWER

By MAJOR GENERAL LEWIS B. HERSHEY
Director of Selective Service

EDITOR'S NOTE: *In view of recent legislation extending the Selective Service Law for another four years, we asked General Hershey to write an article for the* JOURNAL *to show the bearing of the Selective Service process on the matter of technical manpower requirements outside the Armed Forces.*
General Hershey kindly agreed and his responsive statement is presented herewith.

IN ANY DISCUSSION of manpower and its distribution and utilization in the National defense, we must recognize that our present position is unique and new. We must remain at a moment's notice ready to wear any one of several different kinds of hats and to wear each of them well. Whether we have taken this position in the exercise of prudence or just had it thrust upon us is immaterial. The fact is that we could be called upon to shift immediately into any one or a combination of several possible situations. The manner in which we perform in these situations certainly is the measure by which our endeavors shall be judged, and may measure our chances of survival.

The job of the Selective Service System is to register and classify the manpower of the Nation; to determine which individuals at any given time are available for service in the Armed Forces, and which should remain in civilian life for some nationally important reason; and, to select from those who are available the numbers required by the Armed Forces from time to time and deliver them for induction.

The Congress determines which ages shall register and have current liability for military service.

The President, under powers given him by the Congress, prescribes the Regulations governing Classification—which is the process by which Availability is determined.

Local Boards of the Selective Service System, with the advice of specially qualified people in many fields, classify them on the basis of information given by the men themselves, by their employers, or by their dependents. Local Board determinations are subject to appeal to Boards of Appeal and in some instances to the President.

The Armed Forces determine the physical, mental and moral acceptability of men for service in the Armed Forces.

The major functions of the Selective Service System then are: Registration, Classification, Selection and Delivery for Induction.

It is through the process of Classification that orderly manpower procurement really is accomplished, with proper consideration for both the military and the civilian requirements.

Manpower procurement for the Armed Forces is direct in that we find the individual available, select him in his turn and deliver him to the requisitioning service. If he is acceptable he is inducted.

For Industry, Agriculture, Education, and all other civilian activities, manpower procurement is indirect but when so desired in the National interest—especially in wartime—it can be made none-the-less positive and effective.

This is possible because of the general knowledge that the military obligation is upon everyone and, for those within the ages of liability currently fixed by Congress, it is a matter of performance of service in turn, or delay through the medium of a deferment granted for reasons which are in the National interest. Deferment is exactly that—it is neither exemption nor relief from obligation.

Manpower Procurement under the Universal Military Training and Service Act, as amended, has become something more than just a "draft." It is a highly selective process refined by experience which begins with registration at age 18. It could be said that Classification and Selection really begins with the enactment of the Law, for here is considerable selectivity exercised by the Congress in fixing the ages for liability.

AGE AND PHYSICAL condition to a major degree and occupation to a lesser degree are the chief determinants whether or not a man should be selected to go into the Armed Forces or have his training and service deferred so that he may remain for a time in a civilian activity. Elaborating further upon age as a supply and availability factor, we find that our male manpower resources properly are divided into three groups, i.e., (1) *The Prime Military Manpower Group;* (2) *The Secondary Military Manpower Group,* and (3) *The Supporting Civilian Service Group.* These are defined and described more particularly as follows:

The Prime Military Manpower Group is that group within the ages 18 through 25. These naturally include the more physically fit, the less firmly established in the trades, skills and professions, and the man with fewest family obligations. From this group current military requirements should be met (including expansion and maintenance) until such time as a *full* mobilization becomes necessary.

The Secondary Military Manpower Group is that group within the ages 26 through 35. This is the group to which we must turn for requirements over and above the numbers realized from the first group. This group must be drawn upon in the most carefully selective way, for while it will include men still fit and able, they will be older men and men more experienced and mature; henceforth it also will include the greatest percentage of men with prior military training and service. However, this group should not be invaded to any substantial degree until full mobilization has become necessary.

The Civilian Service Group is that group above 35 years of age. Of these very few should enter the Armed Forces except as they are professionals or semi-professionals, and the very specially qualified. To this vast group civilian users must look for the bulk of their *retainable* personnel in any emergency.

It is important to bear in mind that the needs of the military mean withdrawals from the civilian labor force

FEW MEN IN PUBLIC life in this country are better known by name and title than Major General Lewis B. Hershey, Director of Selective Service. On the other hand, probably few of the public generally know very much about General Hershey, the man, who heads this far-flung Federal organization with long arms extending into virtually every American home.

General Hershey has been connected with the Selective Service System since 1936. In a series of progressive advancements he became its Director on July 31, 1941, and was promoted to his present military grade of Major General on April 16, 1942. The Selective Service System is an independent agency entirely separate from the Defense Department and reports directly to the President.

General Hershey was born on a farm in Steuben County, Indiana, September 12, 1893. His Swiss ancestors, Mennonites opposed to war, came to this country in 1709. His varied career has made him successively or simultaneously a farm hand, college student, country school teacher, deputy sheriff, and private, corporal, sergeant, and later officer, of the Indiana National Guard; temporary officer in the American Expeditionary Forces in World War I, and a Regular Army officer since 1920. He has two sons who served in World War II. One, a captain in the Marine Corps, was seriously wounded in Korea. The other, as a lieutenant (J.G.) USNR, served in the Pacific during the war. He also has two daughters.

General Hershey has Bachelor degrees in Science, Arts, and Pedagogy from Tri-State College in Indiana and has received the degree of Doctor of Laws from eight colleges and universities. He has been awarded the Distinguished Service Medal by both the Army and the Navy.

General Hershey's philosophy on the draft emphasizes the autonomy of the local boards as the most democratic selective service process. He has consistently opposed "centralized authority with autocratic power to dictate minutely individual action at the local level."

Employers must not be permitted to embrace the philosophy of retention with regard to either of the first two groups. This is the basic "Classification" which the user of manpower may do himself. He should never deny himself the services of young men, and surely we must never deny young men the fullest possible opportunities for employment, but both the user and the young men should know of the possible realities and prepare to meet them. If we all can grasp the idea that the militarily fit generally must be available to the Armed Forces, we can avoid the costly error of essential civilian activities placing their reliance for an expanded force upon men whom they must eventually release.

ALTHOUGH ALL DEMANDS for manpower are related and are naturally the subject of concern—and even of competition—throughout industry, in this discussion we are directing our thoughts to scientific, engineering and specialized fields of endeavor.

The growing importance of science and engineering to our modern living, as well as to our defense and survival, is thoroughly recognized. Nevertheless, we in the Selective Service System are unable to escape the impression that in nearly every treatment of the subject there is a definite over-emphasis upon specialization and specialized skills in scientific employment, *when considered in relation to the whole national security*. Never before in all our history has the national defense been so generally argued as a reason for remaining out of the Armed Forces. At the date of this writing, when calls upon Selective Service are hardly big enough to keep the machinery in motion, there are some interests and activities still crying and charging that Selective Service is "hampering" industry and even threatening the national defense by "drafting" scientists who are so badly needed. This continues at a time when draft calls are extremely low and when any reasonable man can know that the combined impact of Selective Service procurement and recruiting upon the manpower supply is barely noticeable.

THE FEAR REPEATEDLY is expressed in some quarters that there is an ever increasing shortage of scientists and engineers. We do not deny the seriousness of this prospect. Rather we urge that all interests soberly take cognizance of it. But, we are forced to restrain ourselves and delay any final evaluation of conditions as calamitous until we are given an insight into just how much of this shortage is in defense-supporting activities and just how much of that latter shortage could be satisfied by a transfer of individuals from non-defense to defense activities, or even by a STABILIZATION in essential jobs of those who spend too much time responding to the alluring ads of other employers.

Granted that a shortage of scientists and engineers is threatened, is it not fair, reasonable and probably more productive of good to explore *all* possible causes of that threat instead of leveling so much criticism at one—the most unconcealed agency—the Selective Service System? Selective Service is such an evident, convenient thing to pounce upon that it has long been used as a whipping boy by groups and individuals interested in exemptions and deferments or lesser special considerations. That is the easy thing to do. At times it is even the popular thing to do. It draws a crowd; and, sometimes we discover some really sound thinking friends getting quite lazy mentally and following right along. There are better ways for them to help. Often we hear that Selective Service is

unpopular. We do not believe it. We know that the purpose of Selective Service and the exact truth about its operations often are misunderstood, and we know too that it furnishes a convenient target for scatter-shot charges.

Actually Selective Service, as its name implies, is a *selective* process—the only process whereby the most nearly just and equitable distribution of manpower to users of manpower may be achieved. The entire history of the Selective Service operation, to which thousands of patriotic Americans have GIVEN their services, evidences the soundness of selectivity in military manpower procurement, and witnesses the development and the acceptance of the concept of a universal obligation with timed, selective performance of service.

In their anxiety over the predicted shortage of scientists, chemists, and engineers, some normally very stable-minded people grew critical indeed of the System. Blame for the threatened shortage of scientists and engineers was placed on the Local Boards of Selective Service, and on something vague and vaguely called "Selective Service Policy." Solid American citizens, working for nothing more than to satisfy a sense of patriotic duty—Board Members—were branded as incompetent to understand or pass upon the needs of "science" and "industry." Specific provisions of Law were attacked as whimsical "Policy" actions, "capricious" and "irresponsible," by people who knew not that what they condemned were provisions of Law but who also failed to appear before the Committees of the Congress which were diligently striving to find remedies for the troubles of which they were hearing so much.

THERE WERE OF course many suggestions and some sound, thoughtful recommendations. These ranged from the easiest answer, group exemption—which is prohibited by Law—to the most difficult, centralized classification. Advocates of centralized classification seemed to envision some magically superior group, which somehow could sit in Washington—near unto the visionaries by the way—and know all things about all men.

These discussions were, in spite of themselves, serving a good purpose. More and more people were beginning to see that the fault was much less with the military manpower procurement system than with the manner in which some people were trying to make it work without much care and effort on their parts. Local Boards of average citizens were seen as not so bad, but the information given them too often was found to be quite bad, quite indifferently prepared, and carelessly presented. This was especially true in cases involving some of the newer and more highly scientific and technical fields of endeavor.

In one State where there was an unusually large concentration of young scientists and engineers, the State Director of Selective Service had organized a Scientific Advisory Group to help his Local Boards appraise the information given them, and if necessary to assist in requiring additional facts to guide the Boards in their actions. This arrangement had been watched very carefully by the entire Selective Service System. It had attracted the attention of the Office of Defense Mobilization and others honestly interested in the problem, and apparently it was working satisfactorily. It seemed to provide a means for obtaining superior advice while at the same time the Classification responsibility continued to be decentralized to the communities of the individuals as the Congress had said it should be.

With the full approval and support of the Director, Office of Defense Mobilization, the Director of Selective Service chose six states in which conditions appeared to offer the best opportunity for a test, and he requested the State Directors of those states to seek the services of outstanding scientists, engineers, educators, and other qualified persons to serve as members of State Advisory Committees on Scientific, Engineering and Specialized Personnel. From this test, which was continued over a period of more than a year, there now has grown an indispensable new part of the Selective Service System.

A National Selective Service Scientific Advisory Group serving in an Advisory Capacity to the Director has been established; and State Advisory Committees on Scientific, Engineering and Specialized Personnel are in operation or in process of organization in every State in the Union, in the Commonwealth of Puerto Rico, in the Territories, and in the Virgin Islands, and the Canal Zone. Through membership on these Committees, nearly 300 eminent scientists, educators and other highly qualified individuals throughout the Nation have made their services freely available to the Selective Service System. They should afford to the whole scientific engineering community the fullest opportunity to have the cases of individuals possessing critical skills or engaged in basic research or defense supporting endeavors most thoroughly considered. Selective Service is aware of the problem involving scientific, engineering and specialized personnel, as it is aware of the problems of the millions of other American individuals, with whose lives it deals. Quietly, flexibly, and as promptly as circumstances warrant and permit, the System is taking *real* and *positive* action. This course often fails to satisfy some professional interest servers whose eagerness too frequently overrides their judgment; but years of experience and years of contact with our people and their sons who most are involved, have shown that it is the course which best serves the National interest.

SUPPOSE WE TAKE a brief look at some of the other causes, to which we have commended attention. One of the major shortages is due directly to the fact that fewer men proportionately are entering the scientific and engineering professions. The cause of this is easy to find. Fewer and fewer individuals are entering the teaching profession, particularly in the fields of science and mathematics. Consequently the high schools have been left with the choice of having poorly qualified teachers put on a token performance of teaching scientific subjects; of combining scientific subjects in a general nonconclusive course; or of doing away entirely with science teaching. The road to a degree in science is agreed to be much more difficult than the road to a degree in non-scientific fields. The successful candidate for a science degree demands a measure of dedication—a measure of dedication and determination often fathered by the inspiration gained early under a well liked and a well qualified teacher.

He also deserves especial encouragement even for being willing to undertake the difficult while so many bask in the warmth of praise for high marks in easier courses.

The cause of the shortage of science teachers is common to the *entire* teaching profession and needs little analysis here. Qualified teachers are not attracted by meager wages when industry holds out the lure of equally pleasant hours and working conditions and adequate pay. Who has the responsibility here? Industry? Education? Government? The Selective Service System has noted the problem in this particular area and here again has taken what action it can take. The seriousness of the situation has been made known to all local boards and they have been strongly urged to give every possible consideration to registrants engaged in teaching in the fields of science and mathematics, particularly on the secondary school level. This may help, but here, as in all other lines of endeavor, there is a limit beyond which we

(Continued on page 33)

Grasshopper fossil of the Jurassic Age, 140 million years ago.
Photo courtesy American Museum of Natural History, New York.

Here yesterday . . .

here tomorrow?

In a very old Book, it is written: "The land is as the Garden of Eden before them, and behind them a desolate wilderness, yea, and nothing shall escape them." (Joel 2:3) The reference is to grasshopper damage.
In the United States, grasshoppers inflicted heavy crop losses as early as 1797. In 1877, grasshoppers alone were causing 2 million dollars' damage to crops each year. In addition, many other kinds of crop pests were making serious inroads on all types of commercial and food crops. Growers were constantly faced with the spectre of near or total crop destruction.
Today . . . thanks to modern chemical discoveries . . . things are different! Pesticides such as aldrin, dieldrin, endrin, D-D(R), and Nemagon are powerful weapons in the "battle of the bugs." They kill fast. In some uses, they kill for months and years after application. These pesticides were born of years of research and vast expenditures of money. But research never stands still! Even now, as these pesticides take their place as leaders throughout tthe agricultural industry, Shell Chemical has new pest-killing chemicals in the experimental stage. In time, they too will be ready for effective commercial application. And perhaps Mr. Grasshopper may indeed be "here today, gone tomorrow."

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FOR MORE SCIENTISTS AND ENGINEERS

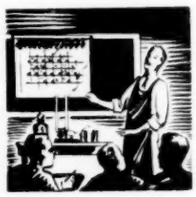
A.F.C.A. $1,000 PRIZE TO BE AWARDED ANNUALLY FOR OUTSTANDING CONTRIBUTION TO HIGH SCHOOL EDUCATION IN SCIENCE OR MATHEMATICS

Action by Board of Directors is in recognition of need for more technical manpower for National Defense

Chapters requested to support program and select candidates for the award

As announced briefly in the November-December issue of the Journal, the Board of Directors of A.F.C.A., meeting in Washington on October 17, took action to establish a prize of $1,000 to be awarded annually to an outstanding secondary school teacher of science or mathematics.

It was the unanimous opinion of the Directors that the Association should give tangible expression to its recognition of the importance of technical manpower in the national defense. The Directors decided to authorize expenditure from the Association's Reserve Fund for the cost involved, taking the view that the seriousness of the technical education problem justifies a substantial financial effort.



Each of the various chapters of A.F.C.A. has been called upon, pursuant to the instructions of the Directors, to cooperate by selecting a candidate for the award from among outstanding public high school or other secondary school teachers of science or mathematics in the chapter area. Details of the program are contained in a letter sent to each chapter president by the national secretary, together with a check list of points to be considered in deciding upon the chapter's candidate. *It is emphasized that for the award this year, nominations must be received at A.F.C.A.'s national headquarters by midnight March 31, 1956.* The letter to the chapter presidents and the check list are set forth herein.

In addition to such cooperative effort by the chapters, it was brought out in the discussion of this project at the Directors' meeting that chapters may wish to establish local award programs of their own to further this move toward increasing technical manpower for national defense, both as to industrial and military needs. It was pointed out that local chapter programs involving the posting of a chapter monetary award would be helpful.

Since the action of the Board was announced information has been received that the San Francisco Chapter has established a $100 prize for an outstanding teacher of science or mathematics in the chapter area. Another chapter action aimed at stimulating education in chemistry or chemical engineering has recently been taken by the Cleveland Chapter. The chapter has voted to present $500 to the Case Institute of Technology in Cleveland as a scholarship fund to be awarded in the amount of $250 for each of two years to an undergraduate in chemistry or chemical engineering.

Letter to White House Conference

The Executive Committee of A.F.C.A., meeting in Washington on November 21, decided to present the views and action of A.F.C.A. in support of technical manpower to the attention of the White House Conference on Education, which was held in Washington during the last week of November. In a letter to Mr. Clint Pace, director of the conference, Admiral N. S. Prime, president of A.F.C.A., stated:

"In company with many other scientific and engineering organizations, the Armed Forces Chemical Association is anxious to do its share in promoting secondary education in the United States, especially in its efforts to inspire youngsters to careers in science and engineering and to impart to them sound preparation for such careers.

"The Association has attempted to inform itself about the present situation and realizes that there are many factors which contribute to the steady decline in the numbers of well educated entrants into the science and engineering schools of our colleges and universities. Of these causes, it has focused its attention on one, the fact that many promising and successful secondary school teachers of science leave the teaching profession for occupations where financial rewards and social recognition are higher. The Association is persuaded that the encouragement of good practicing teachers of science to remain in their profession and to accord this profession some sort of national recognition is one way to promote progress towards the objectives sought.

Hence, the Board of Directors of the Association has established a prize of One Thousand Dollars ($1,000.00) to be awarded annually to a person who shall be judged to have made an outstanding contribution to secondary education in the field of science or mathematics. . . ."

Letter to A.F.C.A. Chapters

The following letter and check list has been sent to presidents of all active A.F.C.A. chapters:

At the Semi-annual meeting on October 17th, 1955, the Board of Directors of the AFCA authorized the award of a prize of $1,000.00 to be given annually to a person who shall be judged to have made, over a period of years, an outstanding contribution to secondary education in the field of science or mathematics. The prize will be designated the "AFCA Award for Secondary School Education in Science and Mathematics" and will be presented at the Annual Meeting of the Association.

Methods of Selection

(a) **Nominations.** Each chapter of the AFCA has the privilege of nominating one candidate for the award chosen by it from secondary school teachers in science or mathematics practicing within the chapter area. The name of nominee selected from each chapter should be forwarded to AFCA headquarters in Washington in time to be received before midnight on March 31st each year.

(b) A committee appointed by the Directors of the Association and designated the "Science Teacher Award Committee" will judge the qualifications of the candidates nominated by the chapters and select one worthy of receiving the award.

Eligibility

To be eligible for consideration, a candidate must be a full-time teacher of science or mathematics in a public, private, or parochial secondary school in the United States, or, having been a full-time teacher, now occupies a full-time position as supervisor of science and mathematics for a group of schools in the United States.

Qualifications

In assessing the qualities of a candidate, highest weight should be placed on the ability displayed in inspiring the interest of students in science and mathematics and in the soundness of the education in these subjects imparted by the candidate. The success of the candidate's students in later college and technical careers is an important index of this qualification. The candidate's own academic training in science or mathematics, both graduate and undergraduate, continuing interest in his (or her) subject, as evidenced by association with scientific groups, specialized courses, or individual scientific work should also be given weight. Account should also be taken of the teacher's adaptability to circumstances surrounding his classroom efforts, his ability to overcome difficulties by ingenious improvisation, his originality in presenting his subject. Finally, his leadership in scholastic and community efforts, his grasp of the requirements imposed on him in preparing students to take their place in modern technological society are matters to be considered in the nomination.

For the convenience of chapters, a sample Check List bringing out important qualifications is inclosed. It is emphasized that the success of a candidate depends largely on how well and fully the chapter describes his qualifications to the Science Teacher Award Committee.

The Science Teacher Award Committee will announce its decision to the Executive Committee on or before May 1st each year.

The objective of this award is to give tangible encouragement to secondary school teachers of science and authorities in this country by giving a substantial prize and national recognition to a teacher or educator who has made really outstanding contributions in attracting students to science and giving them a sound training. It is, therefore, essential that a vigorous and conscientious effort be made to seek such outstanding men or women both by the chapters and the Science Teacher Award Committee. In making this effort, the chapters may find it useful to avail themselves of the help of local agencies such as boards of education, PTA organizations, local educational groups, and the science schools in colleges or universities.

Sincerely yours,

O. E. ROBERTS, JR.
Secretary-Treasurer

CHECK LIST
Points On Which Selection of An Outstanding Science Teacher In Secondary Schools May Be Based

1. Demonstrated ability to inspire interest in science in minds of students.
2. Reactions of students to instruction given as evidenced by:
   (a) Achievements of former students in more advanced science courses at college or university.
   (b) Recognition of former students' ability by industry or scholastic agencies.
3. Individual student's record of achievement in which secondary school's science instruction by candidate may be identified as a factor.
4. Candidate's own academic training in science or mathematics both undergraduate and graduate.
5. Candidate's continued personal interest in science or mathematics as evidenced by:
   (a) His association with scientific groups.
   (b) Continuation of studies in science through medium of summer courses, etc.
   (c) Use of vacation period by working on special industry project(s).
6. Adaptability in utilizing inadequate equipment or to other circumstances surrounding classroom efforts.
7. Ability to overcome difficulties in presentation of subject by ingenious improvisation.
8. Originality in subject presentation.
9. Leadership in scholastic and community efforts to promote a wider understanding of science and its importance.
10. Candidate's general grasp of the requirements imposed on him in preparing students to take their place in modern technological society.
11. Number of students trained:
    (a) Annually.
    (b) In course of career.

This check list is submitted to aid you in the organization and submission of data relating to your candidate. Its use will greatly aid in the maintenance of a National standard. Please add to it such items which will improve this or future awards.

PLEASE NOTE: THE DEADLINE FOR RECEIPT OF NOMINATION FOR THE AWARD IS **MIDNIGHT, MARCH 31, 1956**

NEW R.O.T.C. AWARD PROGRAM

The R.O.T.C. Award Program has been reviewed by a subcommittee of the A.F.C.A. Executive Committee, headed by Mr. Oliver F. Johnson, and procedures involved in making the award have been somewhat revised, Secretary Roberts announces.

Instead of the awards being made to a varying list of universities, it has now been established that the award of a medal with a display case and a scroll will be made annually to students at each of the following institutions:

Massachusetts Institute of Technology.
Ohio State University.
Georgia Institute of Technology.
Agricultural and Mechanical College of Texas.
Purdue University.
St. Peter's College.
University of Delaware.
Vanderbilt University.
Wake Forest College.
Idaho State College.
Oklahoma University.
Carnegie Institute of Technology.
Columbia University.
Cornell University.
Rensselaer Polytechnic.
Iowa State University.
University of Michigan.
Ohio University.
University of Colorado.
University of Illinois.
Rice Institute.
University of Wisconsin.
University of California.

It is believed that by having the award made a feature of the year's training at these universities, it will gain in significance. This assurance that an award will be made at the institution permits an advance showing of the medal and display case, thereby increasing the general interest in the award.

ARMY ENTOMOLOGISTS FIND NEW USES FOR RADIOACTIVE ISOTOPES

By CHARLES C. HASSETT
Entomology Branch
Army Chemical Corps Medical Laboratories

ONCE AGAIN it has been demonstrated that the unexpected bypaths opened up by a scientific problem often give rich and unexpected returns for the cost of research.

Chemical Corps Medical Laboratories have the responsibility for investigating the effects of toxic chemicals on man. An important first step in studying the way poisonous compounds affect the body is to gain the necessary biochemical knowledge of how a particular toxic substance reacts in a test tube, or "in vitro." Biochemists at Medical Laboratories, in studying certain toxics, needed to know their effects on carbohydrate metabolism, and wished to use C^{14}-labelled glucose in these studies. The immediate problem was to find a source of radioactive glucose for the metabolism experiments.

Initial attempts were made to obtain this radioactive compound by growing tobacco plants in an atmosphere of $C^{14}O_2$; this proved slow and unrewarding. Medical Laboratories entomologists in the meantime had reported that 5% of the weight of some insects was glycogen, a compound easily converted into glucose. This led to the idea that insects could perhaps be put to work for the biochemists, in synthesizing radioactive glycogen.

Thus the entomologists at Medical Laboratories entered the picture. Collaboration between biochemists and entomologists resulted in using the vinegar fly *(Drosophila melanogaster)* for this purpose. The flies were known to form appreciable amounts of glycogen daily. Could these flies be induced to produce glycogen containing C^{14}?

This intriguing problem was solved by placing the flies in a sealed container in which $C^{14}O_2$ was released from $BaC^{14}O_3$. The flies not only survived, but continued synthesizing glycogen. When this glycogen was extracted it was found to be radioactive. Purification, conversion to glucose, and subsequent degradation of the glucose to CO_2 and ethanol showed that the C^{14} had been incorporated into the glycogen molecule. As a result the biochemists were provided with a source of the radioactive glucose.

Now the picture shifts from the biochemists and their basic problem, to the entomologists, to see what bypaths this radioactive glycogen problem opened up.

The entomologists at Medical Laboratories were familiar with the fact that there was need of a good system for marking insects, in order to study their flight range and dispersal patterns—an important factor in control of insect-carried diseases. The method currently in use was to spray insects either with a metal powder or a dye, and then release the insects. This method had two definite disadvantages, however. The spray frequently decreased the flying ability of the insect, and the collection and examination of each insect under a lens was a tedious procedure.

Preliminary experiments at Medical Laboratories showed that a radioactive "tag" was much easier to apply and to detect. Mosquitoes could be labelled with radiophosphorus merely by adding $-P^{32}O_4$ to the larval diet. After feeding on this radioactive food the larval grew into adults which were also radioactive. The "hot" insects could be detected easily and quickly by the use of an ordinary Geiger counter. Selection of the proper concentration of $-P^{32}O_4$ produced mosquitoes which were functional in all respects yet were literally "marked" individuals throughout their lives. This method was given field testing by Medical Laboratories personnel in the Hudson Bay area of Canada. It proved to be so successful that it is now in general use for tracing movements of insects.

Another bypath led to consideration of existing methods of control of insect pests by spraying. Studies of the effectiveness of such spraying involved measurement of spray deposits by chemical analysis, a slow and unsatisfactory procedure. The U. S. Department of Agriculture requested Medical Laboratories' assistance in developing a method for measuring spray deposits by incorporating a radioactive material into the spraying oil. The optimum characteristics of the isotope for this purpose were found in gold 198, which has a half-life of 2.7 days and emits both strong beta particles and gamma rays. It is thus readily detected with survey meters, and decays to negligible levels of radiation very quickly.

A quantity of radiogold was obtained from Oak Ridge and dispersed in fuel oil of the type commonly used as an insect spray base. The Department of Agriculture furnished a spraying plane with crew, and test sprays were made on a field at the Army Chemical Center. A survey team was made up from Army Chemical Center personnel, supervised by Medical Laboratories' scientists. It was found possible to measure the spray deposit quickly and with a sensitivity as good as or better than the chemical method.

Still another bypath has led to the studies of protection of various kinds of material by using isotopes, especially uranium pile wastes. Entomologists at Medical Laboratories have investigated the doses necessary to produce sterility and death in a number of pests which attack such stored products as food, clothing and wooden articles. Preliminary experiments with a tantalum 182 source revealed that lethal doses could be administered conveniently, but the low radiation intensity of the material available necessitated long exposure times. Definitive experiments were performed at Brookhaven National Laboratory by exposing large numbers of selected species of insects to the radiation from a kilocurie cobalt ^{60} source producing 193,000 roentgens per hour. Satisfactory lethal exposures required only 20 minutes while reproductive functions were destroyed by 10-minute doses. It was thus demonstrated that packaged materials could be protected from insect infestations by passage through intense fields of radiation, which could be set up by utilizing suitable quantities of isotopic waste products.

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For more facts on Chlorowax, write for new bulletin, *Chlorowax in Flame Retardant Rubber Compounds*. DIAMOND ALKALI COMPANY, Chlorinated Products Division, 300 Union Commerce Building, Cleveland 14, Ohio.

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	CHLOROWAX 70 (solid resin)	CHLOROWAX 40 (liquid)
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Particle size	90% through 50 mesh	—
Solubility in water	Insoluble	Insoluble
Toxicity	Non-toxic	Non-toxic
Odor	None	None
Chlorine content (%)	68-73	40-42
Viscosity (poises at 25 C)		20-28
Evaporation rate (gm per sq cm per hr at 100 C)	0.000004	

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Goodyear Tire & Rubber Company, Akron, Ohio
Grace Chemical Company, New York, N.Y.
Gray Stamping & Manufacturing Co., Plano, Ill.
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Haertel, Walter, Company, Minneapolis, Minn.
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FREEDOM'S NEED FOR THE TRAINED MAN

(Continued from page 5)

20 per cent of their classes—go to college. . . .

Clearly one corrective is money. With adequate funds teachers can be fairly compensated and their numbers thus increased as they become trained and available. But where are the funds to come from? The costs of our school system are only second to those of our defense establishment. It is, therefore, beyond expectation that private or institutional philanthropy could step into the breach.

Does this mean the Federal Government must intervene? Many think so? They hold that a crisis is in effect upon us . . . that it is vital to our defense to have trained men not only at the controls of our complex instruments of warning and war, but especially in the laboratories whence these devices are to come, and that since these men must as a prerequisite come out of our educational system, the system itself must be federally supported, if support is wanting. This is a hard argument to combat. But the consequences of federal support are unacceptable to those of us who would like to see our educational system continue free from dependence upon federal subsidy and from the interference and perhaps control which could follow the acceptance of such subsidy.

Many of us should be thinking of what might be done at once to begin to solve our problem. I have two proposals to advance—one immediate, the other a longer range action. . . .

For the short range I would propose that industry and the professional societies undertake through their organized bodies to popularize a plan whereby every engineer and scientist in the country would volunteer to conduct classes in physics, chemistry and mathematics in our secondary schools, for a few but certain number of hours each month during the school year . . . this procedure . . . would make an appreciable change in the alarming figures now confronting us.

My second thought deals with the longer range problem, would be more difficult to organize, but might solve the problem once and for all. It is simply that the colleges should recognize the gravity of the threat we face and make a certain minimum of credits in physics and chemistry a requirement for enrollment. For instance, if such great associations as the American Council on Education, the Association of American Colleges, the Association of American Universities and the Association of Land Grant Colleges and Universities were to consider and act favorably upon some such a proposition, we would see a great change in the curricula of the secondary schools. . . It is easy to demonstrate also that the costs at the local level will be less than if the funds have to be collected through federal taxation and then fed back to the localities. . . .

THESE SEVERAL SUGGESTIONS will surely be inferior to others that will come from educators who are more conversant with the difficulties than a layman can possibly be. . . . Our position of eminence and influence in the world has been due to the prudent and vigorous applications of technology to the development of our resources and our industrial potential. It has been built on an educational system conducted by independent communities and, until recently, healthily concerned with the cultivation of the natural sciences and mathematics along with the humanities. If we value these possessions which have made for our eminence and influence, we must be prepared to defend them. Our greatest possession—freedom—is itself partly the product of science, since it was technology which made slavery unprofitable, and under freedom and only under freedom all our other treasures flourish.

It is a paradox that we should find ourselves at this point in history suddenly poorer in the very means by which our greatness was achieved.

This is the cold war of the classrooms.

In five years our lead in the training of scientists and engineers may be wiped out, and in 10 years we could be hopelessly outstripped. Unless immediate steps are taken to correct it, a situation, already dangerous, within less than a decade could become disastrous.

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THE ROLE OF BUSINESS AND TO AVOID

By Frank Pace, Jr.

Executive Vice President of the General Dynamics Corporation

This article, a transcript of an address presented last May at the Industrial College of the Armed Forces, Washington, D. C., under the title, "A New Look for Business-Government Relations in the National Security Program," has recently been re-reviewed and is published here by permission of the author and the Commandant of the College. Mr. Pace, who was Secretary of the Army during the period 1950-52, views our presently strong military stature as a potent deterrent of war, but considers such preparedness must continue indefinitely and warns against our yielding to influences toward substantial reduction of our defense budgets.—Ed.

Admiral Hague, members of the Industrial College: This is a most pleasant experience for me. I am going to leave the safety of the podium and the protection of the amplifier and get out here where I can talk to you rather than at you. I will beg your indulgence, because from time to time I will have to at least return and look at the outline that I prepared this morning at five o'clock. Back in the days when I was Director of the Budget or Secretary of the Army, I was able to tackle this situation without the aid of notes, but I find to my regret that, having gone out into the sharp, hard world of business, and having become involved in business problems, my return to this sort of address calls for a little more mental prompting than when I lived with it every day.

I have taken a little poetic license with my subject today, and I want to talk to you on the broader subject of what I think is probably the most important factor in the problems that you will have to meet here at the Industrial College and, ultimately, that you will have to meet in your career, whether it be in the military or elsewhere.

It always seemed to me, when I was Secretary of the Army, that one of the really important problems that we faced was to determine from time to time whether it was our responsibility in the military to seek to avoid the fighting of a war, or whether it was our responsibility to, frankly, prepare for fighting another war. Obviously, the responsibility for the military lay in both fields; but it was also obvious that one or the other must have priority.

It was quite clear to me during that period that, above all else, if it were possible to do so, a war should be avoided. I think that fact has become increasingly clear to the American people with the passage of time. I think that requires a definite caveat, though. I think that war should be avoided only under certain circumstances and under certain conditions. I think war can be avoided only if we are prepared to fight; because, I think, if it ever became apparent to the other fellow that we were not prepared to fight in those areas in which fighting was necessary, then our opportunity to preserve our position in the world would be long gone.

Military Preparedness and Foreign Policy

I think we also have to be prepared to win because I don't think it is possible for our foreign-policy planners to plan intelligently, wisely, or meaningly unless they are planning within the spirit of a program in which winning of the war is a definite determination, if a war comes up.

I was impressed during the period that I was in Government, not only with the close interrelationship that existed between the military and the political planner, but the degree to which the political planner relied upon the military man in reaching his ultimate determination; and I was impressed with the enormously useful background that the military man brought not only to military decisions but also to the semi-political decisions which were forced upon him from day to day.

Unfortunately, in the military political sphere there is no such thing as the clear-cut line of cleavage. There is no such thing as a purely political decision. There is no such thing as a purely military decision. That being true, it becomes imperative that, in the planning that is done in the military field, the most intimate coordination exist between the military and the political.

It has been my feeling that, in terms of any program that we might make to avoid a war, it is imperative that we have the strength to win a war. It has also been my observation, partly personal, and partly by association with men who had lived through a number of wars, that the further you get away from a war the more the inclination arises to fail to keep yourself prepared either for the next war or to avoid the next war.

With the passage of time the requirements for preparation for war become less imperative. I can never forget

GOVERNMENT IN PLANNING WAR

the reaction that, for instance, General Marshall had to the rapid and really unwise demobilization immediately after World War II. I can never forget the growth of the general feeling that the local— by "local" I mean national, as opposed to broad-scale international or military— requirements became increasingly important with the passage of time; and these are not generally foolish requirements—they are necessary requirements.

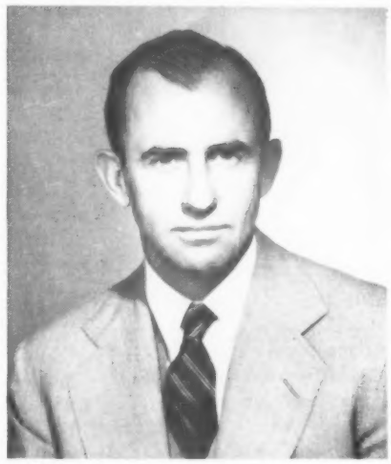
Danger of Pinching Defense Budgets

To the congressman who has a flood-control project in his district, there are going to be acres and acres of worthwhile farmland overrun by the river if you don't build a flood-control project. This is no boondoggle. This is something terribly important to his district. This is something which is basic as to whether he is elected or re-elected. To the Far West, the development of public power is the difference between growth or lack of growth. Therefore, these issues become more pressing, and the proposition of supporting that very large slug of the budget that goes into military expenditures becomes, frankly, less pressing. So, with the passage of time, there comes that normal inclination to pay more attention to local rather than national requirements, which can mean less attention to national defense and less attention to international requirements.

Therefore, for those of us who believe that survival depends upon strength, it is an important and ever present requirement that the emphasis on really consistent, substantial national-defense budgets be continued over a period of time.

This problem is going to become more acute, as we must at some time in the future have some recession in total appropriations. It is not possible to believe that the economy can always move upward and forward, and, as you feel the pinch of economic requirements, again that large slug of the budget that goes into the military appropriations, and all the things that have been drawn under the protection of the military umbrella, sometimes to the detriment of the military appropriation, become a pretty legitimate target.

And I don't think we can look for too much help from the enemy in this regard, as we did from time to time in the past. Whenever it appeared as though military appropriations were going to disappear below the horizon, there was always an effort to take over Greece, and the opportunity to remind the people of America of the importance of preparation arose when the guns began to speak. While this is obviously no time to go into the proposition of whether the war in Korea was either politically wise or necessary, I think there are certain facts that come out of the Korean War which have had a permanent effect upon our thinking in a democracy and which are important to you men in your thinking.



Frank Pace, Jr.

The Honorable Frank Pace, Jr., born in Little Rock, Arkansas, July 5, 1912, was only 38 years old when appointed Secretary of the Army. This assignment, to which he came from a previous government post as Director of the Bureau of the Budget, covered a considerable part of the period of the United Nations operations in Korea. He left the Department in 1952 to take his present position in industry with the General Dynamics Corporation. Mr. Pace has a Bachelor of Arts and Master of Arts degree from Princeton, and the degree of L.L.D. from Harvard and also from the University of Louisville. He was admitted to the bar in 1936; practiced law in Arkansas; served as a major in the Army Air Forces in World War II; and, before becoming Secretary of the Army, held a number of federal government positions, including that of Special Assistant to the Attorney General of the United States, Taxation Division; Executive Assistant to the Postmaster General; Assistant Director and later Director of the Bureau of the Budget.

"Facts That Come Out of the Korean War"

One of the first facts was the understanding of the enormous toll in life and money that even a local war could take on a great nation like the United States. When one adds up the cost of a Korean War in lives or in dollars and then weighs against it the cost of being prepared to avoid such a war, the argument is indeed quite compelling and has made an enormous impression on the public mind.

Secondly, out of Korea came for the first time an understanding that large, consistent, and permanent military budgets were necessary in this democracy. The history of military budgets had been consistently up and down in a jagged fashion that was most uneconomical from the point of view of the national purse as well as the national well being. So, for the first time in history, it became apparent that it was necessary to maintain large, permanent military budgets in peacetime; and this has been, and I think will continue to be for some time, the basis of our national thinking, varying from time to time in degree, based upon the pressures that are put on us.

A third factor that came out of the Korean War, probably known and thought about by military men, but certainly not known and thought about to too high a degree by the civilian, was the enormous advantage that lies with the aggressor.

I remember sitting in those most difficult days in which we were seeking to decide—hours, rather than days—what steps should be taken either to defend against the North Korean or to allow him to have his way, and I remember reviewing the training that had gone into the indigenous South Korean troops, and I remember that, while that training was not obviously all that it should have been, it still was exceptionally fine training. Further, I remember that, although the original decision was to support those indigenous ground troops only with air and naval forces, it was scarcely 24 hours before a statement came that, if we intended to defend Korea, we would have to defend it with people on the ground as well as in the air and on the sea, and I was particularly impressed with the enormous advantage that goes to the aggressor.

I think it would be a tremendously interesting military exercise to proceed upon the assumption that the same state of training existed both in North Korea and in South Korea at that time, but that the South Korean was addressing himself to take over North Korea, and North Korea was interested in maintaining the status quo. The South Korean had the choice of time and the place of attack, and it would be very interesting to see the military conclusions that would be reached as to what would be the result of the same forces, given a change in both attitude and time and place of attack, assuming only indigenous troops. If I had to make a guess, I would guess that, given the same circumstances, the South Korean troops would have gone through the North Korean troops and straight to the Yalu.

But we have today a philosophy born of that conflict that never again shall we be caught in peacetime unprepared to meet our requirements.

Views About Russian Peace Advances

I used to wonder in the latter days of Stalin's life whether the Russians really had a plan for moving our budgets up and down, our military budgets, to the top and to the bottom, because of the way they were then engaging in their alarms and excursions for the purpose of general annoyance. I don't think I, or anyone else, will ever completely know the answer to that question; but certainly it seemed to me that there was a general plan behind what they were doing and that their purpose was to make our operation as uneconomical as possible.

I find, and have found, that it is always unwise to underestimate the enemy. I think that more has been lost by underassessing the enemy than by overassessing ourselves over a period of time, and I would be inclined to believe that his program was a planned one, and I would be inclined to believe that he again would move to try to take us off the plateau, the military-spending plateau, on which we currently rest.

If I were wearing a Russian cap I would say that the greatest deterrent to Russia's ultimate purpose of dominating the world lay in the fact that we have this strong, hard core of continuous and of certain military preparation. I emphasize that word "continuous" because no man could possibly have been more impressed than I with the uneconomic performance that went on as military budgets rose and fell. So when I say "large military budgets," which I think are important, I likewise say "consistent military budgets," because I think they likewise are important. And if I were wearing that Russian hat today I think I would probably want to create an impression on the American people that I was anxious to find a peaceful solution to our problem. I think I would want to have an end to small wars that give rise to an understanding of the importance of military preparedness. I think I would want to soft-pedal the anti-U. S blasts, and I think I would want to indicate that I was willing to participate in some thinking and planning towards an eventual solution.

Fortunately for us, Russia does not control her situation quite as well as I think the lay mind assumes that she does. She has, even as a country that permits the few to dominate its policy, real problems to face. Even a dictator cannot ignore an absence of food and, as their agricultural problems rise, their only solution for those problems is more blasts against the capitalistic world. If uneasy rests the head that wears the crown, uneasy indeed must rest the heads that wear three crowns, and this government that has been so kaleidoscopic and quick changing in Russia is an uneasy and parlous one. Their policies must be dictated by other dictates than their own feeling or desire for long-range domination.

Then, Russia has an ally, a very powerful ally, in Red China. We have found that it is not always simple to work with allies. There is always difficulty in causing national points of view to be sublimated to the international good, and this ally of Russia is not the kind of fellow who bends very easily to the yoke. He is a fellow who has ambition of his own, and desires of his own. It is an uneasy partnership. I am not sure that Russia will be able to follow her plan on the harder course. Certainly I am sure if she could she would prefer to win allies by subversion rather than by firing shots. Whether that is quick enough to satisfy her partner, Red China, time alone, I think, will tell.

But in any event, if she pursues this policy, and if she holds out the dove of peace so pleasantly, and if at some time or another our economy slips back—not slides back, but slips back—then indeed will this nation be faced with one of its gravest political problems, because again that big, fat portion of the budget will look most enticing, and the capacity to balance a budget on reduced taxes will inevitably be revived to the detriment of that particular phase of the budget. There again great courage and great leadership are going to be required in our country, and, in my estimation, they will insure that this essential hard

core, without which we can neither avoid a war or win a war, is sustained and held intact.

Industrial Planning Philosophy

Now, why would I take the trouble to give you my views, which are certainly only individual views, on subjects as broad as these, when our real problem is that of industrial planning and production. I do so for two reasons. The object of this exercise is not for me to make a speech, but to stimulate thinking, whether you agree or disagree with me.

It has always been my philosophy over all that it is tremendously important in any operation, and particularly in an industrial operation, that not only the top echelons but also, as far as possible, the intermediate echelons, and also, as far as possible, the lower echelons know what the total pattern and program is, in order to do their most effective job as a part of that program. I found that, as I traveled around the world in the period that I was Secretary of the Army, most of all, the thing that was exciting was to tell the commander out at the end of the line what really was going on, as far as I knew it, back in Washington. So I think that no industrial planner today, no industrial programmer today, no man who is thinking in terms of production, is thinking fully or wisely or well unless he at least has his own field in the general pattern, not only of things today, but also of things to come.

A second reason is that, as industry and production planners, you talk fundamentally in terms of dollars, and I have found that, with a budget that is an annual budget, and with plans that run five, ten, fifteen, twenty, or twenty-five years into the future, there is a normal tendency to feel that the flow of monies will be approximately what they are at the time you are doing your thinking. I think that is probably as good an assumption as any. But I also think it is an assumption on which you would want some degree of flexibility in your thinking and planning in terms of what might come to be in the future, in terms of the money that would be available to you.

Now let me get down specifically to the proposition of the difference between planning to avoid a war and planning to fight a war. You might ask: Is this really something quite different, or is it the same set of factors with a different name or a different set of denominations? Don't you really have to plan to avoid a war and don't you really have to plan to fight a war, or is this something different? I think frankly it is something different. I think it is different in terms of the way you ultimately have to plan.

There is one area of similarity. Of that I am quite sure. That is that substantial, consistent, military appropriations are necessary to support either. You can neither avoid a war nor fight a war without substantial, consistent military appropriations.

Influence of Planning Purpose

But from that point on you begin to move into spheres in which I think differentiations exist. I think in the first place that you have to, if you are planning industrially, militarily, or otherwise to avoid a war, establish greater flexibility of planning. If you are militarily preparing to fight a war, you have a very specific objective before you. If you are planning to avoid a war, you must plan your military commitments so that you are able to meet the political requirements. I always use "political" in the broad sense. You are required to meet the international political requirements that are established by your own Department of State, and you are also required to plan, in my estimation, in such a fashion that you are able to support an affirmative policy once it is established by the political side of the Government.

Now again, in all these things I realize that many of them are easier said than done. I realize that the military planner often finds that there are no clear-cut political plans. The military planner says, "My God, if they just one time tell me what they are going to do, then I can give them what they want." But again you find a proposition in which perforce and of necessity you are talking about hypothetical situations and undefined goals, and it is in my estimation essential that you maintain a degree of flexibility that you would not normally have to maintain if you were solely preparing to fight another war.

Reward for the Technical Man

I think likewise that it is important in terms of the way you reward people in the military. Traditionally it has been the policy of the military to reward normally the combat man. In my period of time as a civilian secretary, some of my most vigorous arguments were on the subject of rewarding the technical man as well as the combat man. I found that the reasons for rewarding the combat man were not merely some historical precedent nor a desire to satisfy a public demand to recognize a hero, but had some very logical bases. The first was that to a degree it was fair that the man who risked his life should receive a greater reward than one who did not. A second reason, and a sound reason, was that, in order to encourage a man to take the greater risk that exists in combat, either in the air, on the sea, or on the ground, it was imperative that a system be established which rewarded the combat man. Thirdly, it was likewise felt that, in the heat of combat and under the requirements of leadership that come to men in combat, certain qualities evolved that were all-pervading irrespective of what the problem might be. These qualities were essential, irrespective of the assignment of the men under consideration.

Nonetheless, if you come to the conclusion that the purpose is to avoid a war in the future rather than to fight a war, then you come, of course, you and I, to the conclusion that encouragement and development of the technical man is an essential ingredient in the problem of the military of the future.

Two Possibilities for Russian Move

I think likewise that, if you are planning for the avoidance of war rather than the fighting of war, you will tend to place more emphasis on the future than on the present. I think you will tend to put more money into basic and applied research. I think you will probably build a few more prototypes and I think you will take a greater calculated present risk and a lesser calculated risk in the future. To me this seems logical if the Russian is going to move. This can happen on two bases: he might first do so because of some internal compulsion over which we have no control, and thus over which our planning has no control. It is a fact of life. We have to recognize it. We have to prepare for it; but there is very little that we can do about it.

The second basis on which he would move would be his own estimate that he had a clear-cut opportunity to take us in the field of battle without being destroyed himself.

This situation I do not think obtains today, and I do not think it will obtain in the immediate future. However, I think, with the passage of time, and with the emphasis that a society such as the Russian society is able to put on this sort of thing, it is highly probable that the danger will increase. Therefore, logically, it seems to me that in seeking to avoid war and in seeking to keep him from moving the emphasis upon the future rather than upon the present is a logical one.

For Bold Original Thinking

I think that I would urge bold, original thinking in the industrial planner in the military field. Again, that is easy to say, hard to execute. The essence of the military system is discipline. The capacity to give a command and know it is going to be carried out, and carried out well, is essential to success in peace or war, and no man was more impressed than was I with the real advantages that come from the training and discipline that come to the man in the service. But it is likewise true that a discipline system and a system of promotion that is based upon time in grade is not fundamentally such as to produce bold, original, aggressive thinking.

I am perfectly aware that in anything as large as the military, time in grade is a basic factor in a promotional scheme. I am perfectly aware that if you turned it loose to the wisdom of individual commanders the system would be a thoroughly unjust one. But I do feel that the time has come for finding a quicker way to reward in individual cases the kind of bold and aggressive thinking in which if you are wrong you get your head chopped off and if you are right you have given something to the United States of America that is terribly important.

Naturally I should not suggest this without a solution. I am reminded of Will Rogers. He wrote a column in the days of the First World War, when the submarine was such a menace that we were concerned about our survival. Will Rogers came out with a headline in his column which said: "Submarine Menace Solved!" He said: "It has been discovered beyond a peradventure of a doubt that the submarine cannot survive in boiling water. Raise the temperature of the ocean to the boiling point and the submarine menace will be eliminated." He said, "There will be those of little mind who will ask me: 'How will this be accomplished?' To them I say, 'I have given you the program. You work out the details.'"

Partnership With Contractors

I would suggest that, in a period in which one was preparing to avoid war rather than to fight a war, closer contact with your contractors should be kept, if possible. I would suggest that you make them partners, not just as producers, but as themselves, as original thinkers for you, whether you be Army, Navy, or Air Force. This I suggest because out of them one will generate ideas that can be useful to you if they are aware of your planning. They have the opportunity to reward financially. They have the opportunity to promote immediately. They have the resources to put the drive back of the production of ideas. That is important.

Number two, if you do that, your contractor is a better producer if he has played some part in the planning and the programming of what he is producing.

Number three, you will find that, if you do not make your contractor a partner, he will atrophy or die on the vine, unless his men are allowed to participate in the original thinking and planning. If you treat them solely as producers, or job-lot operators, if you like, then those men lose the opportunity for the kind of aggressive thinking that you are going to need when they are your partners, either to build the power to avoid a war, or the weapons to fight a war.

One final suggestion would be, if you can't let the contractors be your partners in the programming and planning, then at least advise them what the plans and programs are; because, again, if a man knows ultimately what this is being done for, and that it is best to do it within the security system, he is a lot better man working for you. He is not really working for you; he is working with you; and that is terribly important.

* * * * *

In the discussion period which followed Mr. Pace's prepared address he developed further some of the points made in his speech. On the subject of planning to engage in rather than to avoid a war he referred to the ammunition shortage during Korea, stating in part:

"The only yardstick you have to plan for another war is what happened in the last war. Any sound supply man in the areas critical to human life will add 50 to 100 percent to the requirement. This procedure has always created a long-range advantage which pays dividends. In the ammunition situation what my technical people did was take the World War II yardstick, in which an awful lot of ammunition was used up, and add a factor of 75 percent to it. It just so happened in Korea that they actually used three, four, or five times the factor of World War II in specific areas of ammunition.

"Now, the reason I say that is, while you have to use that yardstick of experience, be sure you don't use it too inflexibly, because you will get caught . . ."

With respect to wartime procurement planning, Mr. Pace said: ". . . don't underestimate the lead time, no matter what you figure it. Add a little on to it. It just works out that way." Considering the difficult procurement problem of a country under an atomic attack, Mr. Pace cited the importance of mobilization reserves and stand-by facilities. With respect to the latter he added ". . . in my judgment, the ones you are going to be really relying on are ones actively doing business. The others may not get into the act . . ."

In response to a request for his opinion on the idea of depending upon a "production base," that is, a production capability plus some small reserves in being, Mr. Pace stated, in part: "I have always personally favored the proposition of production facilities versus stockpiling. I recognize that with the possibility of production facilities being knocked out in an atomic age you take a chance. On the other hand I have always felt that stockpiling to too high a degree would be built-in obsolescence. With the change in all forms of weapons that exist today, it is absolutely impossible to keep up to date by having scores of weapons in being. You have to have enough to do the job. I admit that there is a great deal of argument on both sides . . ."

Mr. Pace had further occasion to emphasize his thesis of war planning to avoid war when asked whether he considered such planning incompatible with planning to fight a war. He replied: "That's very sound. Frankly, I feel they are not incompatible. They are purely a matter of degree. It is largely a matter of emphasis on one or the other. You do both. Obviously you have to do both to do either. There are areas in which the emphasis can be put on one side or the other. For my purpose I want to see it put in the area of preventing a war as opposed to putting it in the area of fighting a war."

H. A. KUHN

Consultant

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FAMOUS LIGHTHOUSES OF AMERICA

Pigeon Point Lighthouse is located on the Coastal Highway 5 miles south of Pescadero, California. Constructed in 1872, its 115-foot white masonry tower stands on a rocky headland that for many years has been a landmark for ships approaching the Golden Gate from the south. Pigeon Point and the lighthouse are named for the ship Carrier Pigeon, one of the many that came to grief on the outlying rocks in the years before the beacon was built.

Safe Guides to quality in electrochemicals are Niagara Alkali Company's skill and experience in production and its modern facilities for quality control. Put your trust in Nialk® Liquid Chlorine, Nialk Caustic Potash, Nialk Carbonate of Potash, Nialk Paradichlorobenzene, Nialk Caustic Soda, Nialk TRICHLORethylene, Niagathal® (Tetrachloro Phthalic Anhydride).

NIAGARA ALKALI COMPANY

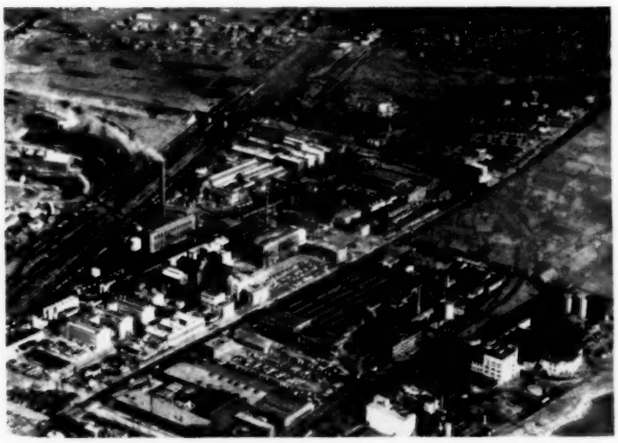
60 East 42nd Street

New York 17, N. Y.

Three-room farmhouse which served as the Hooker Company's office building from 1905 to 1910. A short distance away was a dilapidated old barn which was used as the company's laboratory.

This is the second of a series of articles on the origin, development, and product fields of the sustaining member companies of the Association which reflect the vital role of chemical science in industry in the National Defense. The next article in this series is scheduled for the March-April issue.—Ed.

THE STORY OF HOOKER ELECTROCHEMICAL COMPANY



Hooker's headquarters and main plant at Niagara Falls, N.Y. Spread out over about 80 acres, the plant produces over 100 Hooker chemicals which it distributes to virtually every important industry in the country. In foreground is plant of Niagara Alkali Co., which was merged into Hooker on Nov. 30, 1955.

By R. Wolcott Hooker, *Vice President*

The Background

In America, compared with many of our industrial goliaths, such as coal, iron and steel, and textiles, the chemical industry is a relative newcomer. In 1869, when Elon Huntington Hooker, founder of the Hooker Electrochemical Company, was born, most of our organic chemicals came from Europe; and electrochemistry, which the Hooker Company later helped pioneer, was little more than a laboratory exercise. Today the chemical industry of the United States has no peer. This country produces more tons of more chemicals than any other nation, and electrochemistry, largely an American development, is the basis of a vast industry in its own right.

In spite of the complicated technical nature of industrial chemistry, the Hooker Company was founded not by a chemist but by a civil engineer. Elon Hooker graduated from the University of Rochester with an A.B. degree in 1891 and in 1896 was awarded a Ph.D. degree in civil engineering by Cornell University. After a few years' business experience he launched his own firm, The Development and Funding Company.

The Development and Funding Company was organized to locate potentially profitable but undercapitalized enterprises, and to supply the needed backing and management to put them on a paying basis. This accomplished, subsidiary companies were to be formed to continue the businesses under control of the parent company.

Over 250 projects were examined by The Development and Funding Company before they decided to manufacture bleaching powder and caustic soda, using the recently discovered Townsend eletcrolytic process.

The Townsend process, invented by Clinton P. Townsend, a chemist and patent attorney, and Elmer A. Sperry, who later invented the gyrocompass, was a new electrolytic method for the manufacture of chlorine and caustic soda.

Although the electrolytic principle had been demonstrated as early as 1807, it was not until the late 1800's and the development of the electric dynamo that electrochemistry became a commercial possibility. By then, relatively inexpensive electric power was available and electrochemists centered their attention on developing a "cell" in which the electrolysis of brine could take place.

In November 1903, the Townsend cell was brought to Elon Hooker's attention and within a few weeks The Development and Funding Company had decided to build an experimental plant for commercial testing of the cell.

By the end of August 1904, the tests were completed and Elon Hooker was able to write stockholders: "I take pleasure in advising you that the test of the Townsend cell has proven successful in all respects." The process had proved itself an efficient, inexpensive method of producing chlorine and caustic soda.

The Formative Years

THEN BEGAN THE search for a plant site. The company investigated three cities, keeping in mind the raw materials (salt, water and power) required by the Townsend process. They chose Niagara Falls, which has since become one of the greatest electrochemical centers of the world.

The site was ideal. It was within 60 miles of what is today the largest salt mine in the Western Hemisphere; it was only a few hundred yards from the largest fresh water supply in the world—the Niagara River and the Great Lakes system; and there was the power of Niagara Falls to generate electricity.

Ground was broken May 5, 1905, and by June of the following year production was up to schedule—five tons of caustic soda and eleven tons of bleaching powder a day.

By the fall of 1909, the plant's capacity was being quadrupled and the company was operating comfortably in the black. It was time to set up a subsidiary company which could manufacture chemicals under a more appropriate name than The Development and Funding Company. This was done on November 6, 1909, when the Hooker Electrochemical Company was established as The Development Company's first and, as it turned out, only subsidiary. About a decade later, The Development Company was dissolved and its assets taken over by Hooker.

The Development Company seemed free to go ahead with other enterprises. These optimistic thoughts were dispelled overnight by a disaster which all but wiped out the company's progress.

UNTIL WORLD WAR I, trained chemists were a rarity in American chemical plants. These plants were frequently operated by men with only a sketchy knowledge of hazardous chemical processes. This fact, coupled with primitive fire-fighting equipment and the frame construction of many early chemical plants, made fires and accidents a constant menace. At Hooker the danger area in those early years was the cell house.

When a cell was taken out of operation, the current was diverted around the "cut out" cell by means of a "jumper," which was simply a copper bar temporarily connecting the cells on either side of the one being taken out. When a cell was jumped, sparks flew. These sparks often set individual cells on fire.

The daily operating journal shows that hot cells and fires were quite common at Hooker throughout the spring of 1910:

May 1—Lowered load circuit No. 2A . . . hot cells.
6—Current reduced . . . hot cells.
Current off . . . hot cells.
10—Power off and then on . . . raised slowly as cells boiled over.
26—Cells salting badly through night.

Hard on the heels of this last entry came a disastrous fire. Just after midnight May 27, 1910, fire broke out in the East Bay cell house. Within a few minutes, the oil-soaked timber and blazing cells were sending flames and oily black smoke boiling into the sky. The fire worked into the West Bay cell house, and within minutes its 74 cells were gushing flames. From the cell house, the fire spread to the original frame bleach building and soon was searing No. 1 bleach, the brine tanks, the repair shop, and the drum shop.

Available fire-fighting equipment was hopelessly inadequate and by daylight, when the fire had subsided, Hooker's subdued officials and employees poked through the charred remains of their new 20-ton plant. The cells, the heart of the plant, "lay fallen over like a row of books tipped at an angle."

For five months the Hooker Company was practically out of business. It survived by buying from other chemical companies and reselling to its customers. But by the end of October the plant had been rebuilt.

The new plant was hardly back in operation when an air of optimism began to permeate the company. It was time, they felt, to expand and to build another plant to supply consumers remote from Niagara Falls. After a long investigation of plant sites, the company decided to expand in its own back yard by doubling the Niagara plant's capacity.

It was none too soon. War had broken out in Europe and America's young chemical industry soon found itself matching skills and output with the older, more experienced chemical firms in Europe.

The Impact of World War I

WAR BROKE OUT in Europe in August of 1914. When the war began, the Hooker Company was still producing only two products, bleach and caustic soda. When the war ended four years later, in November 1918, Hooker was manufacturing 17 chemicals; bleach and caustic soda, and 15 new chemicals with a chlorine base.

This sudden diversification was due to two causes: the shutting off of German chemicals during the war and the necessity for finding new outlets for chlorine gas. Meanwhile, the Hooker Company, along with the rest of the American chemical industry, laid to rest forever the notion that American chemists were incapable of competing on an equal basis with European chemists, particularly the Germans.

Even before the war this country's chemical plants were outstripping the Germans in tonnage. But American production, with few exceptions, was confined to simple, inorganic chemicals; the German chemical industry had almost a world monopoly on complicated organic chemicals, such as dyes, perfumes, and medicinals, which are produced synthetically from coal tars.

Shortly after the outbreak of the war, American supplies of coal-tar products, particularly dyes, were practically exhausted. Although shipments continued to arrive from German ports, they were irregular, for when the war broke out the British had imposed an effective blockade on German shipping. The last substantial shipment of German dyes arrived in the late winter of 1915.

Meanwhile, the price for dyestuffs soared. One desperate textile manufacturer paid $2,500 for two kegs of a particular shade of blue which a short time before had cost $16. Patents were granted on dozens of hair-brained schemes for extracting color from nearly everything that grew. The Gold Leaf Natural Dye Company, with a $500,000 investment, was organized to extract golds, browns and other colors from autumn leaves.

At the same time, responsible chemists were establishing an American coal-tar chemical industry. Dozens of new chemical companies sprang up during that year, while others expanded their facilities in an effort to furnish dyes and medicinals to starving textile firms and pharmaceutical houses. To help supply this insistent demand the Hooker Company, in 1915, built the first monochlorobenzol plant in the United States. From this beginning, came the scores of highly diversified Hooker chemicals manufactured today.

Hooker monochlorobenzol production started in September of 1915. At the end of the war, with an output of over 1,500,000 pounds a month, it was the largest monochlorobenzol plant in the world.

At first, nearly all of Hooker's monochlorobenzol production was gobbled up by impatient dye makers. But by

the end of 1916, most of this production had been diverted to an even more urgent use, the manufacture of picric acid, an explosive.

The plight of the munitions manufacturers matched that of the dye makers. The most common explosive, trinitrotoluene, or TNT, was manufactured through toluol, a coal-tar crude, excessively scarce throughout the war. Substitute explosives had to be found. One of these was picric acid, normally manufactured from phenol by a somewhat roundabout method. Unfortunately, this method consumed great quantities of two other acutely scarce chemicals, sulfuric acid and caustic soda. Although picric manufactured through monochlorobenzol required both of these chemicals, it used substantially less of each. The French government to conserve its dwindling supplies of caustic soda and sulfuric acid, had already begun the manufacture of picric acid through monochlorobenzol. From the beginning of 1916 until the end of the war, most of Hooker's output of monochlorobenzol was shipped to France for conversion into picric acid.

The United States was drawn into the war in April 1917, and by September, was itself faced with an estimated shortage of about 150 million pounds of picric acid. Two-thirds of this, it was decided, could be made up by manufacturing picric through phenol; it was hoped the remaining 50 million pounds could be manufactured through monochlorobenzol, a process almost completely unfamiliar to American chemists.

Within two months, Hooker chemists had helped demonstrate the ability of American chemists to master the intricacies of industrial organic chemistry. Working in a tiny experimental plant called the grandstand, these chemists in an astonishingly short time, had worked out a method of producing picric acid from monochlorobenzol and were prepared to supply the government with two million pounds of this substitute explosive.

Picric acid and monochlorobenzol were probably the two most urgently needed chemicals produced by Hooker during the war. But they were by no means the only ones. About this time the company established its first research department—an active, vigorous group of chemists who, during the war years alone, added 15 products to the Hooker list.

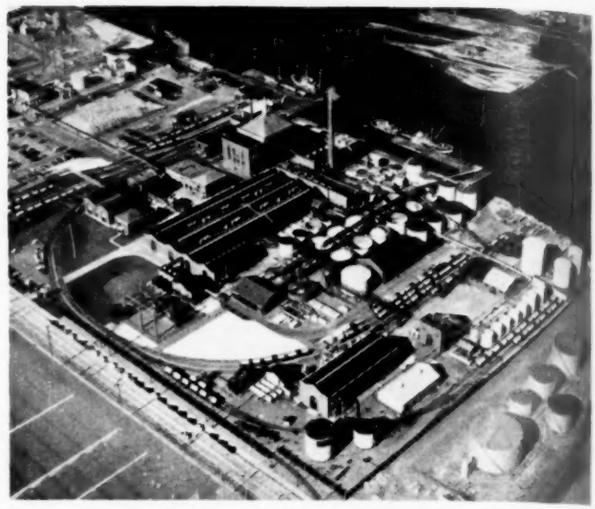
The new research department developed processes for the manufacture of chlorate of soda, sulphur chloride, and other chlorinated chemicals which helped siphon off the excess chlorine gas. Had they failed, it would have been necessary to cut down chlorine production. This would have reduced proportionately the output of caustic soda for which the war had created an almost insatiable demand.

Caustic is a simple, unglamorous chemical with none of the drama of the coal-tar derivatives, but it has scores of everyday uses. By the end of the war, the export price for this "workhorse" chemical had jumped from about $30 a ton to $200 a ton. To meet the demand, Hooker enlarged its plant during the winter of 1915-16 to 62 tons of caustic a day.

Despite the usual war time shortage of men, materials, and power, Hooker's plant not only ran—for four years it turned out record tonnages of critically needed war materials. With the abrupt ending of the war in the fall of 1918, the ability of the American chemical industry to turn out record tonnages became a liability which was almost the industry's undoing.

The Aftermath of the War

IT WAS ONE THING to win the war and quite another to survive the victory. When the war suddenly ended, on November 11, 1918, Hooker was faced immediately with falling prices, an overexpanded and run-down plant, an oversupply of raw materials and electric power, and worst of all, cancellation of war contracts which left it with an excess of 25 tons of chlorine a day.



Hooker's Tacoma, Washington, plant. Strategically located in Tacoma Harbor, the plant—one of the most attractive of its kind in the country—for over 25 years has supplied chlorine and caustic soda to western industry. Its capacity has increased more than twelvefold during the past 25 years.

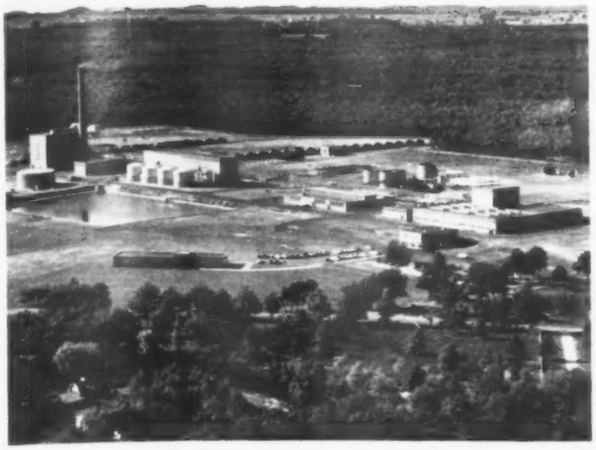
The falling off of the export market coincided with a drastic slackening of domestic demand. By the fall of 1920, Hooker, along with all of American industry, found itself in a severe slump. By 1921, the slump had developed into a full-blown depression which hit almost every industry using Hooker chemicals. The depression which began in 1920 and intermittent price wars within the industry caused Hooker to operate at loss for a couple of years. But by 1925, the chemical market had recovered and Hooker, which had developed more efficient manufacturing processes, was in a strong competitive position.

In the same year, the engineering staff began work on a new phase of cell development—the deposited diaphragm—which led in a short time to a radically new and superior Hooker cell.

The deposited diaphragm was the most important cell development in the history of the company. It tremendously simplified the construction and renewal of the diaphragms; it lowered voltage and increased current efficiency; it prolonged the life of the cell and improved the purity of its products, particularly the chlorine. Above all, it made possible the construction of the simplest, most compact and efficient cell in the company's history—the Hooker Type S cell, which today, with modifications, is licensed to 28 American and foreign companies and produces more chlorine than any other type of cell in the world.

At about the same time—the late twenties—Hooker built its first branch plant, on the Pacific Coast. As early as 1912, Hooker had investigated the Pacific Northwest, but there was not enough demand at that time to justify a West Coast plant. An enormous potential was there, however, and over the years the company kept a watchful eye on the region. By the 1920's the Northwest had begun to expand, population increased, and, most important, the pulp and paper industry in that section began its tremendous growth. At the same time, there was a demand for caustic in the rapidly growing oil refining industry in California. The time now seemed ripe to establish a West Coast chlorine and caustic soda plant.

Hooker's Tacoma, Washington, plant went into production on February 4, 1929, with a formal opening on the 16th of that month.



Hooker's chlorine-caustic soda plant at Montague, Michigan. Situated on White Lake adjoining Lake Michigan, this plant went into production in March 1954, and is part of the company's multi-million-dollar post-war expansion program.

Durez Division's Basic Research Laboratory at Le Roy, N.Y. In these laboratories, located about 50 miles from the main plant, Durez chemists devote their time exclusively to basic research.

This plant, the first chlor-alkali plant in the Pacific Northwest, was a success from the day it opened. The plant prospered throughout the 1930's, made tremendous contributions to the Allies' cause during the war, and has expanded greatly in the post-war era, keeping pace with the explosive industrial growth of the West Coast. In addition to supplying some of the world's largest paper and oil companies with chlorine and caustic soda, the Tacoma plant was the first in the Northwest to produce ammonia. Over the years the plant has been enlarged and modernized, and its capacity has increased more than twelvefold during the past twenty-five years.

With a West Coast plant established, the company turned its attention to the further growth and development of its Niagara plant. That growth resulted from the research program inaugurated in the depression years which lay just ahead.

Depression Decade

THE STOCK MARKET collapse in the autumn of 1929 brought the "roaring twenties" to a disastrous close. By the end of 1932, the United States found itself in the worst depression the country had ever known. Stocks were worth little more than a tenth of their 1929 values, about 13 million people were unemployed, and the national income had been cut in half.

Yet during the next few years, while hundreds of thousands of businesses failed, the chemical industry earned itself an enviable reputation as "the depression-proof industry." New plants were built, production capacity was increased, and by 1937, the industry had surpassed its record production of 1929.

The chemical industry's excellent record during the 1930's resulted mainly from its development of synthetics. The chemist's ability to create substitutes for natural products apparently is limited only by time, money, and apparatus for research. During the depression, as millions of dollars were poured into research, the industry produced thousands of new chemical products.

It was during this period that the list of Hooker products expanded from about 30 to nearly 70. Within the next 15 years, additional products were developed, so that the list of Hooker chemicals, including the Durez and Niagara Alkali Divisions, has grown to several hundred during the past half century.

This rapid increase in Hooker's products was in part the result of the company's first sustained, vigorous research program. The research department was organized in December 1914. With the collapse of the post-war chemical market in the depression of 1920-21, research work was substantially curtailed and the department virtually marked time for a decade.

But in 1929, despite the excellence of the Hooker cell and the efficiency with which the Niagara plant was run, it became clear that the company's future depended upon broadening the scope of its operations. Hooker was vulnerable because it relied too heavily on the sale of its basic products, caustic soda and liquid chlorine, both periodically overproduced. The only safeguard lay in producing a wide variety of processed chemicals with a chlorine, caustic, or hydrogen base. By 1932, the research and development department had been reactivated, refurbished, and given the job of developing new products.

The success of the research program accounts in large part for the enormous strides made by the company

North Tonawanda, N.Y., plant of Durez Division of the Hooker Company. The Durez Division, one of the industry's most fully integrated producers of phenolic resins, supplies a wide range of industries with resins and molding compounds which are processed into thousands of plastic materials used regularly in everyday life.

during the next 15 years. It produced the dozens of new Hooker chemicals which today serve over 30 basic industries, and reach consumers in many forms, including fuels, lubricants, pharmaceuticals, textiles, paints, plastics, soaps, insecticides, perfumes, leathers, and furs.

In the process of expanding its product list, the company developed a number of Hooker firsts. Among them were chlorinated paraffin and organic sulfides for extreme pressure lubricant additives; Lindane, a particularly effective insecticide; and Hetron, a line of fire-resistant plastics.

On the death of Elon Hooker in 1938, his brother Harry succeeded to the presidency. His first major decision was to move the company's executive offices to Niagara Falls. The advantages of the move were almost incalculable. For the first time there existed a tight liaison between the front office and the plant; decisions, painfully slow in the past, were greatly speeded up.

The move was made at an opportune time. Within three years the United States was at war again. At no time in Hooker's history was there a greater need for prompt decisions and for quick decisive action throughout the company, from research through operations to sales.

World War II

While Americans were riding out the depression, Europeans were keeping an anxious eye on Hitler. Their anxieties proved justified September 1, 1939, when the German army smashed across the border into Poland. Chamberlain's wistful "peace in our time" had not materialized. Instead, Hitler had plunged Europe, and very soon the world, into a general war. By June of 1940, there was little between the Axis Powers and world conquest except British courage and the industrial might of the United States.

In the time between the march on Poland and Japan's attack on Pearl Harbor, December 7, 1941, the United States was shipping millions of tons of war supplies to the British and we had become the "arsenal of democracy." This time, in contrast to the days of World War I, Hooker and the American chemical industry were prepared for an all-out effort.

In the 25 years between Kaiser Wilhelm's war and the war begun by Hitler, the American chemical industry had reached maturity. No longer was it dependent upon European leadership. Two and a half decades had seen it transformed from a timid imitator into a bold leader. The industry produced nearly all domestically-used dyes, most of our organic chemicals, and it had developed the largest plastics industry in the world. In World War II there was no dye famine, and the acute shortages of potash, nitrogen and coal-tar chemicals, which existed during World War I, were no longer problems. By 1939, the United States was the greatest producer of chemicals in the world. With the exception of synthetic rubber, the Armed Forces got the chemicals they needed, when they needed them, from the American chemical industry.

With the fall of France, the United States hastily began to shore up its defenses, and by the end of 1940, American industry was mobilizing itself for war. The Hooker Company and the rest of the chemical industry put aside peace-time plans. For the next five years Hooker devoted its energies to supplying other industries and the government with the essential ingredients of war.

Hooker chemicals found their way to the fighting front in such forms as smoke pots and colored flares, and indirectly, by sale to other industries, where they were processed into indispensable instruments of war.

Disinfectants, for example, seem relatively unwarlike. Yet during the first World War, more soldiers died from measles than were killed by poison gas. This catastrophe could have been avoided with adequate disinfectants. During World War II, Hooker produced thousands of tons of chlorine which was processed into disinfectants, the "preventive medicines" which saved thousands of American lives.

The common shoe is seldom thought of on a par with dive bombers, tanks, and bazookas. Yet when the Duke of Wellington was asked: "What is the first requirement of a soldier?" he replied, "A good pair of shoes." Shoes require chemicals. To help supply 12,000,000 men and women in the Armed Forces with footwear, Hooker shipped millions of pounds of sodium sulfide, sodium sulfhydrate, and sodium tetrasulfide to the leather industry, for use in the tanning process. These chemicals were also used in the manufacture of dozens of other leather products urgently needed throughout the war.

As important as shoes are, they were relatively less important in World War II than in the Duke of Wellington's time. The Duke's soldiers traveled on foot; ours traveled, much of the time, in countless thousands of vehicles. Ask a modern general what the first requirement of an army is and he would probably answer "petroleum." Petroleum is now essentially a chemical product. Almost every phase of petroleum production, from "cracking" to the manufacture of high-octane, anti-knock gasolines, requires tremendous tonnages of chemicals. Hooker plants helped keep our Armed Forces mobile by delivering thousands of tons of caustic soda and aluminum chloride to the United States petroleum industry.

A mechanized army, although it had all the fuel it needed, would still be unable to turn a wheel without a variety of lubricating oils and greases. Nor could it, for that matter, keep its rifles, revolvers, and cannons firing or its battleships at sea.

This was dramatically pointed up in the North African campaign in the winter of 1942-43. Tankers, freighting fuel and lubricating oils across the Atlantic, were being lost at an alarming rate. A lubricant shortage was fast developing, which threatened to paralyze the Allied Forces contending with Rommel for North Africa.

A hurry call was sent to the petroleum industry for more lubricants. Lubricating oils require chemicals known as "additives," some of which prevent gears from binding under extreme pressures. While the Allied Forces in North Africa hoarded their dwindling supplies, chemical firms raced to provide the petroleum industry with indispensable lubricant additives.

Hooker produced thousands of tons of chlorinated paraffin and organic sulfides to meet this dangerous shortage. In a few months the Axis Powers were driven from North Africa, but, for a time, a mere film of oil stood between them and victory.

Perhaps the greatest achievement of the chemical industry during World War II, and one in which Hooker played a leading part, was the enormous expansion of the synthetic rubber industry. When the defense program got under way in 1941, the United States was producing about 15 tons of synthetic rubber a day against a rubber consumption of 2,000 tons a day.

Three months after Pearl Harbor, the Japanese overran Malaya and the Dutch East Indies, the source of over 90 per cent of the world's natural rubber supply. The United States began to stockpile rubber in 1941, but it was too late. When our supplies of natural rubber were cut off, we had enough on hand to keep our economy and our war machine running for less than one year. The problem was dropped into the lap of three industries: petroleum, rubber and chemical. Their combined efforts produced one of the greatest industrial achievements of

all time. By 1944, America was producing more synthetic rubber than the total of "all supplies imported from southeast Asia before Pearl Harbor."

Hooker dodecyl mercaptan played a crucial role in the race to produce synthetic rubber. By the end of the war Hooker was furnishing more than a half-million pounds of dodecyl mercaptan per month to the Rubber Reserve, a government agency in charge of the synthetic rubber program. Hooker's production accounted for about 800,000 tons of synthetic rubber, nearly 50 per cent of the total GR-S synthetic rubber produced by the entire industry.

Hooker, on December 8, 1943, was included among those to receive the Chemical Engineering Achievement Award for its contribution to the nation's synthetic rubber program.

These products only begin to tell the story of Hooker chemicals in the second World War. There were others: arsenic trichloride for poison gases; hexachlorobenzene for landing flares; and bleaching powder, urgently needed by the Chemical Warfare Service for decontamination. And there were dozens more used in metals, medicines, dyestuffs, plastics, soaps, rayons and other textiles. They suggest something of the chemical nature of modern warfare and of Hooker's role in helping to win the war.

In addition to the chemicals produced for the war effort, Hooker furnished the Chemical Warfare Service with the Hooker Type S cell and performed a number of other special services.

During 1942-43, 1,200 Type S cells were installed at Edgewood and the three other chlorine-producing arsenals: Huntsville, Alabama, Pine Bluff, Arkansas, and Rocky Mountain Arsenal, near Denver, Colorado.

Hooker not only furnished the cells for the government chlorine plants, but company engineers and chemists also acted as consultants on the design of plants, supervised the installation of equipment, and trained CWS operating personnel.

Hooker also furnished the Chemical Warfare Service with a new method for manufacturing thionyl chloride, urgently needed for poison gases, and through the Tacoma staff, made substantial contributions to the government program for procuring magnesium.

Hooker also played an important role in the Manhattan Project which developed the atomic bomb. For its part in this project, the company received the Chemical & Metallurgical Award and a special Army-Navy "E" Award. Hooker continues to play a prominent part in this program through its operation of an Atomic Energy Commission plant at Model City, New York.

The defeat of the Axis Powers was due, ultimately, to the deluge of products pouring from the American industrial machine. Whatever the product, be it bazookas, bombers or battleships, or even the Army's bugles (some of which were made of plastic), they were fabricated, to some extent, from chemicals.

As a leading chemical manufacturer expressed it: "Whatever the Army and Navy have wanted from our chemical industry they have gotten almost as simply as turning on the faucet to draw water." Hooker helped keep the reservoir filled by turning out a total of about two and one half billion pounds of chemical products during the war years.

The Post-War Era

THERE WAS WILD celebrating and dancing in the streets on V-J Day, August 14, 1945, when the costliest war in America's history was over. But beneath the exuberance there was uneasiness about the future.

By October, many leading businessmen, economists, and government officials were predicting a "reconversion depression." The economy sagged when the government cancelled about thirty-five billion dollars worth of war contracts, but it snapped back almost immediately.

During the war, Americans had worn out their cars, clothing, radios, furniture, household appliances. Now they wanted new equipment and furnishings, and they had over one hundred and forty billion dollars in savings. In the country's history there had never been so great and so insistent a demand for industrial goods.

To help meet this demand, Hooker undertook the greatest expansion program in its history. They developed a program to modernize the Niagara plant, to increase the basic capacity of Niagara and Tacoma, and to add to the growing list of Hooker chemicals.

The results were spectacular. Hooker's investment in plant and equipment rose from less than $15,000,000 in 1945, to nearly $99,000,000 in 1955. During the same period about 30 new chemicals were added to the Hooker list, and chlorine capacity was increased from 212 tons per day to over 840 tons per day. This increased capacity resulted from expanding plant facilities at Niagara Falls and Tacoma, from building a new $15,000,000 plant at Montague, Michigan, and from merging with the Niagara Alkali Company.

In addition to building its Montague plant, Hooker began construction in 1955 of an $11,000,000 chlor-alkali plant in North Vancouver, British Columbia. This plant will be operated by Hooker Chemicals Ltd., a subsidiary, and will go into production in early 1957.

Hooker, in partnership with the Detrex Corporation of Detroit, Michigan, also built two new plants for the production of chlorinated solvents: one is at Tacoma, Washington, and went into production in January 1947; the other at Ashtabula, Ohio, went into production in June 1950. The Hooker Company operates these plants while Detrex markets their products.

As another part of its expansion program, Hooker, in July 1953, bought the Marble-Nye Company of Worcester, Massachusetts. Founded in 1771, this firm had acted as Hooker's exclusive sales agent in New England for nearly fifty years.

From its new plants and the increased output of its old ones, Hooker sales have climbed spectacularly in the past decade, from about $19,000,000 in 1945, to roughly $93,000,000 in 1955. This is perhaps the best evidence of the success of the company's post-war expansion program.

New plants and increased sales are not the only evidence of vitality running through the company in the post-war era. There have been a number of other changes.

While Hooker's reputation has been built on chlorine and caustic soda products, the company in recent years has become firmly established in the plastics field. Hooker entered this burgeoning industry in two ways: by developing a plastic of its own—Hetron, a line of strong, tough, fire-resistant resins with almost limitless possibilities for the future; and by merging, in April 1955, with Durez Plastics & Chemicals, Inc., one of the world's largest manufacturers of phenolic resins and molding compounds.

By consolidating with Durez, which now operates as the Durez Plastics Division of the Hooker Company, Hooker has acquired a firm with three plants, a modern, efficient research laboratory at Le Roy, New York, highly-trained personnel and 34 years experience in the manufacture of phenolic resins and compounds.

Seven months after the consolidation with Durez, Hooker merged with the Niagara Alkali Company.

(Continued on page 41)

PROCUREMENT OF RESEARCH AND DEVELOPMENT BY THE ARMY CHEMICAL CORPS

By ALFRED C. BENSON
Chief, Engineering and Field Service Division
Research Procurement Office
Army Chemical Center, Maryland

★ **Range and kind of services**

★ **Information to be included by contractor in contract proposal**

★ **How sources are selected**

★ **Basis for decision on contract award**

DESPITE THE SIZE and duration of the Research and Development Contract program, questions on the above subjects are often received by the Chemical Corps. Each of these subjects plus contract administration will be explained by setting forth the primary goals of the operation, the overall policies, and the operating procedures now in use.

ULTIMATE GOAL OF RESEARCH AND DEVELOPMENT

The ultimate goal of the Defense Department is to design, develop, and build weapons, equipment, and materials that are measurably superior to those of potential enemies of the United States. The mission of the Chemical Corps is to accomplish this ultimate goal in the fields of chemical, radiological, and biological warfare. "Obvious," you might say, but it should be stated as it leads into basic policy.

BASIC POLICY

To achieve the above goal the Corps must subject its problems to the efforts of the best brains and facilities available. This is axiomatic and represents the keystone of Chemical Corps policy. In private business the available brains and facilities are often restricted by competition to one's own organization. The Government, however, is in an unique position in this respect. The goal established is one in which all organizations and individuals in the country agree on; therefore, there is no inherent deterent against calling in outside aid. In fact we say that for all practical purposes the Research and Development organization of the Chemical Corps includes every trustworthy organization and individual in the United States and in some instances it may include those in other friendly nations of the world. The problem therefore becomes one of establishing machinery to locate those organizations or individuals that are best qualified for each task, to obtain proposals from them on the problem, to establish a working arrangement with the "one" that presents the best overall proposal, and to administer the resulting contract in a manner that will obtain the greatest results from the efforts contracted for.

DESCRIPTION OF RESEARCH AND DEVELOPMENT WORK PLACED ON CONTRACT BY CHEMICAL CORPS

We have, I believe, a fair overall picture of the ground to be covered but before we start going into detail it might be well to establish the scope of the Research and Development program and to define such terms as basic research, applied research, design, etc., as they are used in the Chemical Corps.

Range of Program—Selection for Contracting

The range of work within the Research and Development program extends from basic research to the final engineering improvements based on mass production experience. Any portion of this work or the entire program may be put out on contract depending upon the origin of the program,* the classification and magnitude of the work, the availability of personnel and facilities, and the amount of funds required.

[*Programs that originate from suggestions submitted by a facility outside the Government are considered the private property of the originator if so designated; therefore, these programs would be placed on contract with the originator unless his rights were relinquished.]

Definition of Terms

The Research and Development programs of the Chemical Corps are generally broken down into six distinct phases which are identified and defined as follows:

Basic Research

The investigation and study of specific materials, combinations of materials, or phenomena for the purpose of extending our knowledge and establishing possible useful correlations with problems within the overall responsibilities of the Chemical Corps. The "products" of this phase are generally reports and experimental data.

Applied Research

The investigation and study of basic principles and techniques believed capable of providing a solution to a specific problem. The "products" of this phase are also reports and experimental data.

Design

The creation of a device, a material, a process, etc., having the theoretical potential of satisfying a need. Full use is made of applicable design data resulting from research and other previous work. The "products" of this phase are working drawings, specifications, etc., and sometimes a "mock-up" or crude working model.

Development

The process of repeating the cycle of designing, building, and laboratory testing a "raw" design until an effective, dependable, reproducible, and economical design which fully satisfies all of the military requirements is obtained. In converting the "raw" design to a "finished" design, changes are made to satisfy the requirements of

dependability under all environmental conditions, safety, stability in storage, mass producibility at a price commensurate with its military value, and prudent use of strategic materials. The "product" of this phase generally includes toleranced working drawings, specifications, directives, one or more prototypes, and tooling if applicable.

Experimental Production and Engineering Testing

The production of a limited amount of the product, in accordance with the drawings and specifications developed under the previous step, to permit extensive testing under controlled conditions by engineering personnel. Tests are performed to determine the characteristics of the item and a measure of its ability to meet military requirements. The "product" here is represented by the items, tooling for the product, and generally design changes as dictated by experience of production.

Mass Production on Limited Scale for "User-Tests"

The production of a quantity sufficient for the testing of the product by the using troops under field conditions. Items are made under mass production conditions to obtain a measure of the suitability of its design for high production. The products here are a finished design ready for standardization, production tooling, and the items.

LET'S GET ON WITH THE PROBLEM

Right about now I can hear the average reader muttering, "All right, you've educated me on background, policy, purpose, etc., etc. When do I find out how I can get into the program? What do I have to do after I'm in? What's your basis for award? How does the contract operate after it's placed?" This is a big order and the answers can't be served up just like that. If this article is going to serve some useful purpose, if the procedures described are to be understandable, it will have to provide background and logical reasons for the procedures followed.

We all realize that procedures are designed to satisfy basic needs. They may not always be entirely successful, but their designing aim is to satisfy, and their content is generally the result of the needs and problems encountered. With this in mind a frame of reference for Chemical Corps procedures will be provided by establishing what needs and problems contractors and the Government have in connection with Research and Development procurement. These problems are somewhat like the rocks in a mountain stream; by knowing what the rocks are like, the apparent crazy contortions of the water may become understandable.

PROBLEMS CONFRONTING CONTRACTORS

To start with I'll set down the contractors' problems, or at least those I know about. Let us start from the time a contractor decides he would like to participate in the Government Research and Development program. Most contractors feel it is incumbent upon them to have a representative contact all the different Research and Development centers, to become familiar with the proper Government personnel, and to "root around" and see what programs are being planned. This is a hit or miss procedure and I know many contractors do not like it.

The next problem comes up when a request for a proposal is received. If the project is big the cost of preparing a first-rate proposal is considerable; therefore, the contractor must balance this cost against his chance of receiving the award. If he decides to bid, the contractor must study the problem; settle on a solution or group of solutions to the problem to establish his technical superiority to other bidders; estimate the costs to effect his solution; establish a time schedule for accomplishing the work; and provide all other information required by the Government. It is Chemical Corps policy that when delivery is not an important factor, time for opening bids from date of issue will not be less than thirty days.

THE GOVERNMENT TOO HAS PROBLEMS

Contrary to the belief that the Government has no real money problems because it prints the "stuff," the entire program does operate on a budget. The money required for each program must be estimated several years in advance and if the estimates are too high the program may be shelved; if too low, the effort may be spread too thin. In other words, the estimate must be not too high, not too low, but just in-between. Furthermore, overall budgets are often insufficient for the desired program; therefore, the Government must pick its targets carefully — it cannot afford to "scattergun" research.

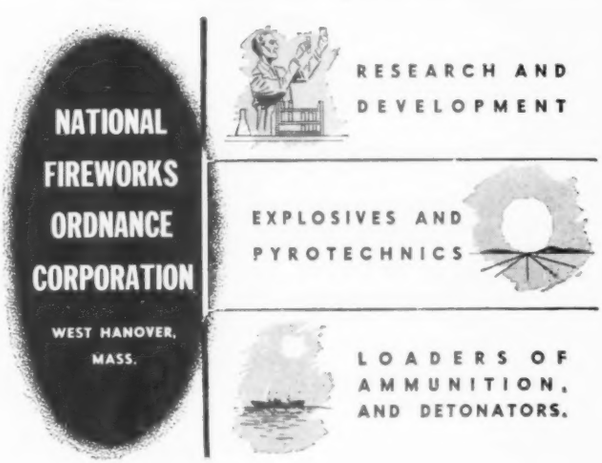
Approval of the funds and advancement to the contracting phase brings fresh problems; such as, how does the Government select *"the best source"* in a manner that is fair to all, that will keep the costs of making proposals to a minimum, and that will insure the maximum degree of competition required by regulations? Whenever more than one proposal is being considered, how can an honest evaluation of the problem be distinguished objectively from just "window dressing" presented by a skilled proposal writer? What is to be done when suspected "window dressing" is combined with low costs?

ANALYSIS OF PROBLEMS

From a study of the above problems it is apparent that to be effective the contracting procedure should include the following:

1. An effective method of compiling a list of outstanding sources for each project.
2. Some objective means by which contractors can exhibit their technical evaluation of the project. (This evaluation is to provide the major factor in the selection of the source to contract with.)
3. A basis for accurately estimating the costs for completing the project as *initially* envisioned. (It is clearly understood that actual work on Research and Development projects often indicates the need for major changes or even suspension of the work.)
4. All means possible to reduce the cost of preparing proposals short of reducing the effectiveness of the above three points. (A cost of 3% of the entire program is not unusual. Since the average contractor prepares five for every one he gets the total cost becomes 15%. This is an amount worth whittling down.)

With the above summation as a background the procedure for contracting for applied research and development will now be explained. (Basic Research and Procurement of "sole-source" Services represent a small percentage of the total work load and do not present major procurement problems so they will not be discussed here.)



PROCEDURE FOR CONTRACTING FOR APPLIED RESEARCH & DEVELOPMENT SERVICES

The procedure consists roughly of six steps:
Selections of sources to be solicited.
Establishment of final scope of work.
Solicitation of proposals.
Evaluation of proposals.
Negotiation of final contract.
Contract administration.
Each of these steps are explained in detail below:

Selection of Sources

The list of sources for each program to be contracted for is compiled by the Government technical and contracting personnel responsible for the classification of work involved. The selection is based upon their familiarity with the leaders in their field, their location, past experience, current interests, and availability for additional work. The last factor changes rapidly; therefore when a program comes up, the availability-factor is brought up to date through a series of visits to contractors believed qualified. During these visits the program is discussed in general and the contractors' availability and interests are established. The visits also provide background data for finalizing the scope or description of the work.

Establishment of Final Scope of Work

The "scope of the work" is that part of the legal agreement between the parties which spells out what work is to be done. Vagueness and all-inclusive broadness represents the unknown which is universally feared, particularly in legal agreements; therefore, particular pains are taken in the scope to clearly explain the purpose of the project, the conditions under which the work will be accomplished, the part that each party to the agreement will play, and the schedule which will be followed in accomplishing the work. Scopes therefore generally contain information covering the following elements:

1. Background data.
2. Clear statement of problem.
3. Detailed listing of requirements to be met by solution to the problem.
4. Limitations imposed by other allied projects or activities.
5. Type and amount of participation to be provided by Government personnel.
6. Schedule of performance desired.
7. Items to be furnished by Government.
8. Items to be furnished by contractor.

Solicitation of Proposals—Instructions for Their Preparation

After completion of the scope, prospective contractors are forwarded copies of "Request for Proposal" which includes the scope of work to be performed and a description of the information which is to be furnished in the proposal in order to permit a thorough and fair evaluation. This information which is to be furnuished by the contractor includes the following:

1. A technical approach to problem.
2. The background of contractor--related work accomplished.
3. Description of applicable facilities of contractor available for use on contract—laboratory, field, laboratory equipment and etc.
4. A list of personnel available for proposed contract—resumes of key personnel who will participate in the program including their direct experience applicable to proposed work. (Contractors are of divided opinion on submitting this information. From the Government's point of view it is buying largely the competence of the individuals that will work on the contract. Employment by a large, well-known company does not automatically raise the I.Q. of the employee ten points and many competent men prefer the homey, friendly atmosphere of a small company.)
5. A brief description of organization for laying out, coordinating, and checking the work accomplished.
6. Estimated "time-schedule" for accomplishing each phase of the work.
7. Detailed cost estimate.

Where it is believed necessary, a general meeting of representatives of each prospective contractor is held usually within two weeks after the requests for proposals are sent out. The meeting is held for the purpose of clarifying all questions and for exhibiting applicable material, equipment, etc.

Evaluation of Proposals

Evaluation of proposals are made on the basis of the factors cited above, under the instructions for preparation of proposal. Pre-award surveys of actual facilities are made necessary to verify details contained in proposals.

Negotiation of Final Contract

The final contract is negotiated with the source that submits the proposal that provides the most overall benefit to the Government. This contract must reflect the intentions and understandings of both parties on each and every element of the project. It might be well to comment here that some contracts in the past have not reflected the intentions and understandings of both parties. This lack was not intentional but rather has been the result of the high plane of the discussions and the interest of the work itself which often creates an aura of trust and a reluctance to discuss "small details." In fact the contracting parties have often acted like lovers—so much in accord and attune through telepathic means that mere words were superfluous. Too often, contracts of this type have ended up like many love matches after marriage, when the actual day-by-day operation of the agreement brings to lights the full intentions of both parties.

CONTRACT ADMINISTRATION

Contract administration is a story in itself. However to provide a working knowledge of Research and Development contracting the "high-points" will be covered to round out the picture.

Need for Government Participation

Two types of participation are involved in most contracts: technical and administrative.

The technical participation is required to provide a Government evalution of the work accomplished and to provide the contractor with background data not generally available in industry. The frame of reference for the bulk of Research and Development work of the Chemical Corps consists of the peculiar conditions that

exist as a result of the operations of the Armed Forces, such as in combat. The specialized knowledge concerning these conditions, the extent to which they exist, their effect, etc., is mainly in the hands of Department of Defense personnel and is provided to the contractor by the Government Project Officer.

The administrative participation is required to accomplish the myriad of duties, necessary for efficient contract performance, that are not purely technical in nature. These duties include mechanical inspection of items produced after approval of prototypes, shipment of property, compilation of records for tooling, determination of status, auditing of costs, making payments, etc. These duties are performed by personnel other than the Government Project Officer in order to permit him to devote his full time to the technical aspects of the contract.

In Retrospect

Although I do believe the Chemical Corps is making a persistent effort to satisfy all of the primary needs for efficient Research and Development contracting and has improved over the past years, careful analysis of our procedures will reveal a lack of real progress on cutting costs in estimating, increasing the time for submission of proposals, and increasing the assurance in the selection of the most competent source. The cost of estimating still runs high, shifts in overall Department of Defense planning combined with the fiscal year limitations on funding often cause uncontrollable limitations on time for requesting proposals, and price or the cost estimate often tends to work against the overall aim of obtaining the services of the most competent.

It is interesting to note that when the program is based upon a concept submitted by a contractor many of the above problems are minimized by virtue of negotiating with a sole source. Estimating becomes more accurate since the contractor is working from a relatively superior knowledge of the subject matter, he is virtually assured of recovering his costs of estimating, the competence of the contractor is established by the value of his "idea," and finally the overall time of obtaining a firm contract is reduced by the elimination of many of the steps cited under the procedure for soliciting from multiple sources. If some means of introducing effective competition could be combined with the system of negotiating a contract with one source, a simpler and more effective system might be developed.

What would happen if the Government were to deliberately solicit ideas and comments on its problems on a formal basis? A system is envisioned wherein panels would be established, one for each major field, made up of members prominent in that field. When problems arose they would be written up in detail and sent to all members of the appropriate panel for comment and submission of concepts of solutions believed worthy of investigation. This solicitation would serve the purpose of obtaining competition. From the point of selecting the best solution, the Government would be in the position of dealing with a proprietary source and thus would receive all the advantages cited above. Panel members could submit an estimate of the time, manpower, facilities, and materials required to put their proposed solution into effect, therefore simplifying the estimating problems. Further, if negotiations were to break down with the originator of the "best solution" the Government could always then turn to the "second best solution." The program would be, in effect, an industrial mobilization for research activities. How about it? Would this method of operation be preferable to the present method, wherever it were applicable?

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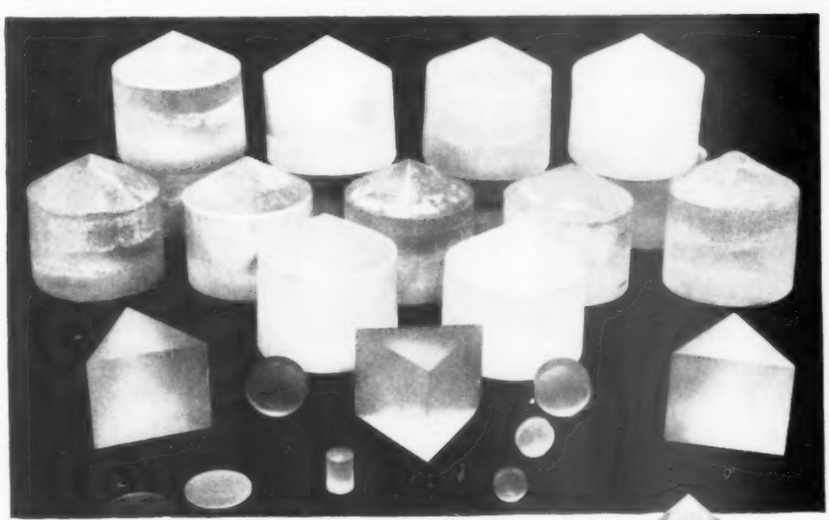

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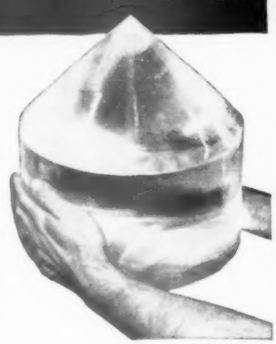

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A MESSAGE TO PROSPECTIVE EXTENSION COURSE STUDENTS

By COLONEL MAURICE A. PEERENBOOM
Chief, Extension Division, Cml. Corps School

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Perhaps your assigned unit is too far distant or you are otherwise prevented from attending your unit meetings. In such cases the extension course work credited to you will make up those deficiencies and give you the credit needed for YOUR future retirement as well as build your longevity pay. Remember, for each 2 years of creditable service your rate of pay will be increased from 2 to 5 dollars a month dependent on grade and length of service.

Accomplishing the extension courses will provide you with the basic knowledge required of your next higher grade and will make promotion easier when you have completed the required time in grade.

The Extension Courses of the Chemical Corps School have been revitalized during the past year and new courses are now available. The Atomic Defense Series will be interesting in its new light. A brand new Military Accounting Course is now available to assist you in understanding the new Army Accounting System.

So write without delay to the Extension Division, The Chemical Corps School, Ft. McClellan, Alabama, requesting the Prospectus of Extension Courses, list of exemptions, and enrollment blanks. They are free of cost to you and will assist you in helping yourself to a bigger pay, both now and when you reach retirement age. Remember, for each $10 per month you receive in retirement income you would have to save and set aside $2400 for an equivalent non-military annuity. So figure the value just 2 hours a week of your spare time will bring you—and at no cost to you.

Commissioned a second lieutenant in 1926, Colonel Peerenboom served with the Wisconsin National Guard from 1930 to 1940. He was Division Chemical Officer of the 32d Infantry Division from 1940 to August 1942 when he became Deputy G 3, U. S. Army Service of Supply —Southwest Pacific Area. In 1947 he was integrated into the Regular Army. After serving as Chief, Plans Branch, Office of the Chief Chemical Officer; Instructor and Executive Officer of the Military Arts Division of the Chemical Corps School; and as Chemical Instructor and Assistant Professor of Military Science and Tactics at Ohio State University, Colonel Peerenboom was assigned as Chief, Extension Division, The Chemical Corps School, Fort McClellan, Alabama. Colonel Peerenboom received a B.S. degree in chemistry from Lawrence College, Appleton, Wisconsin. He is a member of the Technical Association of Pulp and Paper Industry and the Armed Forces Chemical Association.

SELECTIVE SERVICE

(Continued from page 8)

cannot go in "subsidizing" activities with deferments from military service.

ANOTHER REAL FACTOR to be considered—one touched upon previously in this discussion—is utilization. It is not exactly untninkable, nor perhaps unreasonable, to expect the transfer of qualified engineers and scientists from non-defense supporting activities to defense activities in which shortages exist.

The question of utilization raises again the bogy of salary. What of the qualified engineer who leaves the laboratory to avail himself of the higher salary and increased security of the engineering sales field? Of the Management Field? Of permanent vs. Defense production? Where may the answer to this problem be found? In more liberal deferments? Or is it asking too much to assume that employers have a responsibility here?

Considering utilization further, what proportion of qualified engineers are engaged to the limit of their ability and capacity? One of the charges hurled against the military is that engineers are drafted to serve as riflemen, etc. What about the engineer who is doing routine work on jobs which could just as well be filled by a lesser qualified individual? An engineer handling a rifle well, may be of considerably more service to his country than a qualified engineer spending his time at a drawing board on a routine assignment contributing nothing to the national defense.

There is probably less reason to under-use a scientist in civilian employment than there is to under-use his scientific qualifications while he is in the military service. Few people in an expanded military force are privileged to serve by doing only those things which are similar to their civilian occupations, skills or professions. Yet there are many necessary duties and essential services to be performed for and within a civilian community. These things are not separate and apart from the purely military job. Instead they are essential in support of it, and if the personnel of a military unit is to become so overspecialized that individuals do either only civilian type or military type duty, then the resourcefulness and self-contained power of our forces to sustain themselves are in danger of being lost.

A well-worn charge against the military and against military training and service is that young men are forced to train and serve and never use anything they learned in school or college. There is here an implied serious indictment of manpower utilization in the Armed Forces. I am not prepared to say that I have always felt that manpower utilization in the Armed Forces has been all it should be, but certainly I am less prepared to say that it would be any more unfair than the implied indictment if someone some day asked whether or not the schools and colleges are teaching anything that can be used.

One last word concerning utilization. In spite of all of our scientic knowledge and achievement, science has not yet been able to classify either man or job with ultimate precision, and that capacity which does exist is too often warped by the interests of the classifier. It has never been demonstrated that in a society such as ours any professional group or guild can be allowed to make their own determination as to the measure of their contribution or the justification of their contribution to the national security. One of the prices of our kind of society must be the willingness of all to participate in some of the elemental things concerning the common defense. In great emergencies the public will endure variations which they will not tolerate in time of peace.

THOSE WHO SEE such cause for alarm in the present situation often, without meaning to do so, cloud the issue by crying that we are sadly and alarmingly behind Soviet Russia which nation is said to be producing scientists and engineers at a far greater rate than we are here in the United States. These individuals quote figures which are indeed interesting but again we hesitate to make or accept any final appraisal of them without some other information. Intelligence of this sort needs to be related to something our informants on Russian scientific progress too rarely mention. We should also consider the number of Russian young men who are being trained as bomber and fighter pilots. Similarly, what about the numbers being trained as gun crews? What is the ratio between young people being trained for scientific fields and those being trained for the military? If we are to attempt even to project anything like an accurate estimate of the situation we must examine *all* the factors. We can't isolate any portion of the picture and claim it to be the whole picture. We must look at all of it, or we may be sadly deceived.

Finally, in treating with scientific and engineering personnel, we are dealing with a *specialized* group. Now consider that a military effort will require the employment of men in the Armed Forces in other than their normal pursuits, professions, or preferences, and in ways in which little practice or skill is gained in usual civilian activities. Well! you have there a kind of "specialty" too. Preparation for military service and survival is "training and utilization of specialized personnel" no less so than is training for a civilian profession. If anything, it is even more highly specialized and it certainly is less easily acquired than is civilian training, for until recently no opportunities have been offered our young men to receive such preparation except in time of war. Then it is too late!

Every time we have made an attempt to define "specialized" personnel, we have found ourselves either ex-

(Continued on page 41)

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Rubber—a Vital Factor in the Modern Air Weapon[1]

By Horace C. Hamlin, Major, USAF
Wright Air Development Center, Dayton, Ohio

Reprinted from "Rubber World," Volume 132, pages 601 through 607, 614, August, 1955.

There can be no doubt that the chemistry and technology of rubber and rubber-like materials have made impressive progress in the past two decades. We find, however, on summing up our accomplishments against our most urgent requirements that, in some respects, at least, we are a very good ten years of intensive research behind the times.

I refer, of course, not to automobile tires and the myriads of other more prosaic everyday applications for rubber, but to the very serious and almost impossible-to-comprehend current and near-future requirements inherent in the machinery responsible for the preservation of our free and prosperous existence.

During World War II there were, comparatively speaking, no serious material problems. Today, a scant decade later, aeronautical science has virtually solved all problems of flight from here to anywhere at any speed, except those of the materials to make the vehicles.

Tonnage-wise rubber is a rather small item in the total structure of any air vehicle, but from the standpoint of the inferno that may result from its functional failure, or the design problems involved in its elimination, it ranks very close to the front as a major item limiting aeronautical development. This statement may be verified by noting the various committees of the Society of Automotive Engineers, Aircraft Industries Association, and the military services devoted to working out our difficulties.

Problems Involving Rubber

Now, what specifically are some of these problems, and why are they so difficult? These modern air weapons of ours (both in being and yet on the drawing boards) are flying both higher and faster than anything previously conceived. The higher altitude achieved by these planes together with the necessity of their being instantly operable in Arctic regions, require some materials which will function dependably below —80° F., while the increased velocity capabilities of these planes result in increased aerodynamic or air friction heating.

To demonstrate this point better, please note Figure 1, which depicts graphically the heat produced by friction between air and the exterior surface of the plane (skin) as speed increases. The upper curve depicts temperature increment; while the lower one shows actual skin temperature based on an ambient temperature of —67° F. as shown at 0 mph. on the lower curve. Note that skin temperature begins to become extremely serious at about 1,600 mph., a speed that has already been achieved. It is well worth noting that the air temperature of —67° F. mentioned corresponds roughly to an altitude of 50-60,000 feet. At lower altitudes in air of greater density, the problem becomes much more acute at comparatively modest speeds.

The third problem is both chemical and thermal, and it is a direct result of the need of increased power, speed, and altitude. Higher engine operating temperatures have necessitated the development of new synthetic lubricants. Higher-pressure hydraulic systems have done the same for hydraulic fluids. Some of these fluids and lubricants are the types of chemicals to cause problems with rubber, but the prime difficulty is heat. These fluids may get extremely hot. In many cases temperatures have passed 350° F. and are moving rapidly toward 450 to 500° F. and beyond.

The same difficulty is experienced with fuels. Even the fuels may reach very high temperatures because it has been found that preheating produces better combus-

[1] Presented at the annual meeting of the Molded, Extruded, Lathe Cut & Chemically Blown Sponge Subdivision of the Mechanical Goods Division, The Rubber Manufacturers Association, Inc., Hot Springs, Va., June 16, 1955.

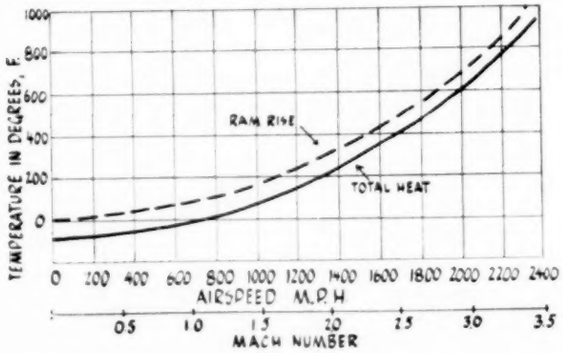

Fig. 1. Aerodynamic heating (temperature rise of exterior surface of plane with increasing speed) at air temperature of —67° F.

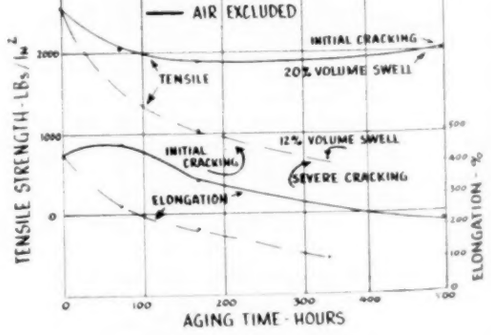

Fig. 2. Physical properties of nitrile rubber compound aged in diester lubricant at 350° F., with and without air.

tion, and/or because bulk fuel makes a good heat sump. When the problem of the more exotic propellants, such as are used in rockets is added, the temperature situation becomes even more complicated.

The most common problem in this area of airplane fuels today comes from trying to cope with fuming nitric acid, an excellent rocket fuel oxidizer, but one of the most violent and dangerous chemicals known.

Other problems in connection with the use of rubber in aircraft exist, of course, such as, how to obtain better mechanical strength, compression set, elasticity, and ozone resistance. The need is of tires good at 500° F., fuel tank sealants good from —80° to 500° F., and others. Every rubber application poses many problems, but the greatest of these is heat. Heat is a deadly enemy of all organic materials, and 500° F. is not the end; actually it is much closer to the beginning of Air Force requirements. Requirements for rubber materials serviceable at 1,000° F. are not too far off.

Better bomb-bay and cabin seals, fuel tanks and sealants, coatings, O-rings for fuel, lubrication and hydraulic systems, fuel and oil hose, accumulators, diaphragms, and wire and cable covers, without which none of our present-day aircraft can be operative, these, and many more items, numbering literally into thousands and weighing up to several tons are the problems involving rubber. So what can be done about them?

Three Solutions

There are three ways of attacking the problem.

One solution is to do away with rubber as completely as possible. In some applications this has been attempted more or less successfully, but only at the expense of increased labor, greater weight, greater cost, and possible reduced life of the aircraft part.

Another approach is the development of compounds from existing rubber materials, which, when laboriously tailor-made for a given application, will have somewhat increased serviceability. This method has and is being used with some success which, however, when matched against the requirements, is seen to be quite marginal.

The third approach, and potentially by far the most fruitful, is research in polymer chemistry leading to the development of new polymers which will meet these demanding Air Force requirements.

What of the materials we have on hand, and what can be done with them? Today we have natural, GR-S, neoprene, Butyl, nitrile, Thiokol, silicone, the acrylic type rubbers, and one or two others. In some respects they are doing a terrific job far exceeding what was previously considered to be their performance limits. Nitrile rubber has been for years the rubber work-horse for many aircraft applications, but above 300° F. its service life is drastically shortened. Neither natural nor GR-S type rubber will fare any better, generally worse. At 400° F. neoprene embrittles rapidly. The silicones are yet unaffected at this temperature, but they lack the needed chemical resistance. The acrylics show improved heat resistance, but at the expense of low-temperature properties and solvent resistance.

For example, nitrile rubber with its very well-known fuel and oil resistance has been for a long time the material chosen for seals for engine lubricating systems. The development of jet propulsion, however, has greatly increased the operating temperatures of these lubrication systems and has consequently necessitated the development of improved lubricants from synthetic products. The synthetic lubricants in current use for these applications are produced from such alkyl diesters as dioctyl sebacate, which, incidentally, is a pretty good rubber plasticizer.

At 350° F. and above in the presence of diester lubricants together with entrained oxygen, nitrile rubber can be shown by laboratory tests to have extremely short life. Figure 2 shows the difference in properties of a typical nitrile rubber compound aged in synthetic lubricant with and without the presence of oxygen. It is unfortunate that lubricating systems entrap considerable air. This nitrile rubber, nevertheless, is what is now being used with more or less marginal success in this application.

The problem of obtaining more suitable hose, seals, etc. for lubricating systems is considered so important that a very thorough study under a research contract of all possible available materials has been made for the Air Force. The result of this study turned up an acrylic rubber as the best possible compromise. The rubber is Hycar 4021.[2] Figure 3 shows how this acrylic rubber withstands synthetic oil immersion for up to 500 hours at 350° F. Its volume swell of about 40% is, however, not desirable, and its low-temperature serviceability, limited to about 0° F., is quite inadequate.

Hydraulic systems, which are at least equally important as lubricating systems, are likewise beginning to operate at higher and higher temperatures. Here again, as naturally occurring materials fail, synthetics are being developed to replace them. One such fluid now being tested for hydraulic applications is made from an alkyl silicate ester.

Figure 4 covers two types of hydraulic system seals for high-temperature service. These compounds, developed at WADC, were made to cover two temperature ranges; the neoprene works from —65 to about 400° F, while the acrylic works from about 32° to 550° F. for a short period of time. Needless to say, one material covering the temperature range of both of these elastomers and good for many, many times longer service is needed badly. Such materials as these are, however, giving at least limited service now.

[2] B. F. Goodrich Chemical Co., Cleveland, Ohio.

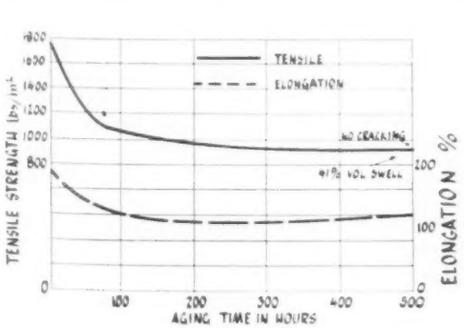

Fig. 3. Physical properties of acrylic rubber compound aged in diester lubricant at 350° F. for periods up to 500 hours.

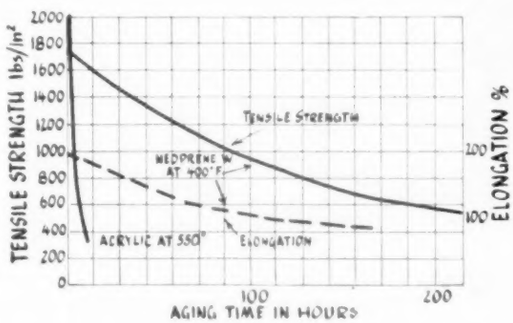

Fig. 4. Physical properties of hydraulic-system seals made of Neoprene W and an acrylic rubber after aging at 400 and 550 F., respectively.

To point out better the sacrifice being suffered through marginal rubber performance, it can safely be said that the development of reasonably satisfactory high-temperature hose seals would offer a bonus of well over an additional 100 mph. in aircraft top speed through elimination of heavy cooling devices.

For resistance to fuming nitric acid, Butyl rubber is probably the best of the commercial rubbers. Even so, its service life is limited to but a few hours' direct exposure. Figure 5 shows the effect of white fuming nitric acid on three Butyl rubber compounds.

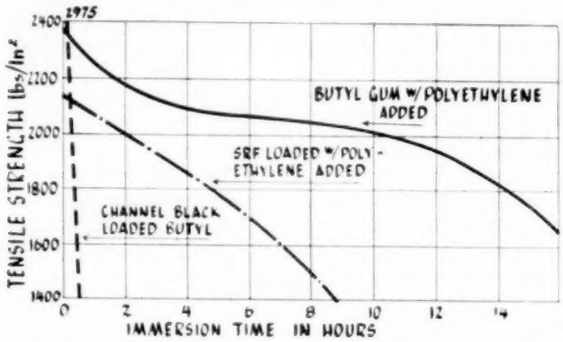

Fig. 5. Effect on tensile strength of three Butyl rubber compounds on immersion into fuming nitric acid

TABLE 1.
EFFECTS OF ATOMIC RADIATION ON GUM RUBBER COMPOUNDS

Exposure X 10^{18} NVT	Tensile Strength	% Elongation	Shore Hardness
Polybutadiene			
0.00	670	360	49
.25	460	—	67
.54	280	20	79
1.30	1200	2	98
Hycar OS-10			
0.00	1240	375	52
.25	1600	180	67
.54	800	70	77
1.30	3600	25	100
Neoprene GN			
0.00	2520	475	62
.25	990	45	85
.54	1900	20	99
1.30	3300	2	100
"Hypalon" S-2			
0.00	2410	250	78
.25	1800	38	90
.54	1500	6	96
1.30	3000	2	100
Natural Rubber			
0.00	2250	460	47
.25	430	65	67
.54	400	30	80
1.30	110	2	92
Hycar 4021			
0.00	610	235	45
.25	340	60	55
.54	300	30	70
1.30	500	3	80
Hycar OR-15			
0.00	1270	310	59
.25	1600	110	76
.54	2600	45	97
1.30	7800	2	100
Thiokol ST			
0.00	1100	195	70
.25	630	90	75
.54	400	60	72
1.30	450	70	73

Correct compounding can make an appreciable difference in the performance of a particular rubber in a particular application, especially when the materials performance is, at best, marginal. The difference may be between function-ability and failure. Thorough compound and process engineering is vital in such applications, but is far from a total solution.

Effect of Atomic Radiation on Rubber

In keeping with the latest developments in science—the Air Force, The Atomic Energy Commission, and The National Advisory Committee for Aeronautics have been studying the feasibility of an atomic powered aircraft; the development of which would introduce into materials engineering an entirely new environmental problem, namely, that of nuclear radiation, already recognized as unfriendly toward many organic substances. In the event of such a development, knowledge of possible effects on organic materials is essential. With respect to rubber we would need to know specifically which of the available elastomers might be used at all, how to predict their service life, and how, perhaps, to extend that life through proper compounding.

In order to present a clear comparative picture of the effects of radiation on several rubbers, Table 1 shows the results of an initial screening test conducted on a representative group of compounded and vulcanized, but unreinforced elastomers.

The table first shows four compounds—polybutadiene, Hycar OS-10,[2] (a butadiene/styrene elastomer). Neoprene GN,[3] and "Hypalon" S-2.[3] It is interesting to note that all four of these materials follow a similar behavior pattern. All are rapidly reduced to almost 0% elongation. All become very hard, and they all increase in tensile strength. The tensile improvement, however, in each case follows a distinct drop, which may be explained by initial chain scission followed by extensive cross-linking.

Table 1 shows also four polymers, which behave somewhat differently when exposed to atomic radiation. Natural rubber is rapidly and severely degraded in all properties. Nitrile rubber, on the other hand, exhibits an almost linear increase in tensile strength, exactly opposite to the result in natural rubber. Hycar 4021, an acrylic rubber, shows a rather in-between effect; while Thiokol[4] demonstrates at least percentage-wise, the best retention of original physical properties of them all. Butyl and other isobutylene polymers, when exposed to atomic radiation, result in a sticky mess which could almost be strained through a sieve.

It is to be hoped that analysis of these results coupled with many other tests now in progress will help in some measure to solve the problem of producing a more resistant rubber. The mere fact that some diverse results were obtained is cause for some mild optimism.

An Air Force sponsored research program being conducted by The B. F. Goodrich Co. is continuing the study of radiation effects on rubber. It is expected that one result of this study will be information leading toward the development of more radiation-resistant rubber products for a variety of Air Force applications.

In addition to the work leading toward improved rubber compounds for all applications being carried out in the several military laboratories, considerable support is being currently provided through contractual research programs being conducted by a number of highly competent organizations—such as Goodrich, Firestone Tire & Rubber Co., Goodyear Tire & Rubber Co., United States Rubber Co., Wyandotte Chemical Co., Minnesota Mining & Mfg. Co., Boeing Aircraft Co., Battelle Memorial Institute, and others. These contractual efforts have been of great assistance in our effort to get the most from the materials now available to us.

[2] E. I. du Pont de Nemours & Co., Inc., elastomer division, Wilmington, Del.
[4] Thiokol Chemical Corp., Trenton, N.J.

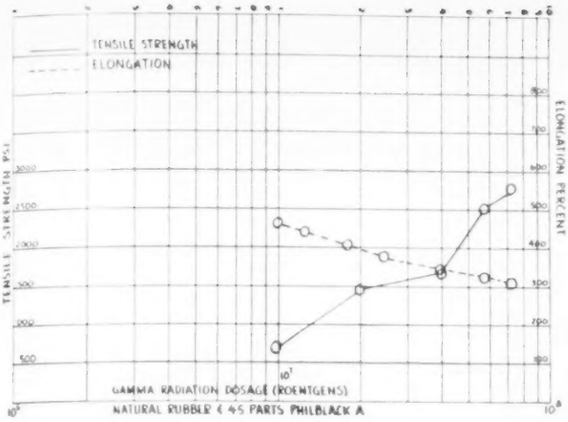

Fig. 6. Effect of gamma radiation on natural rubber/MAF carbon black mixture. Note that a dosage of between 2 and 4 x 10^7 Roentgens produces useful physical properties.

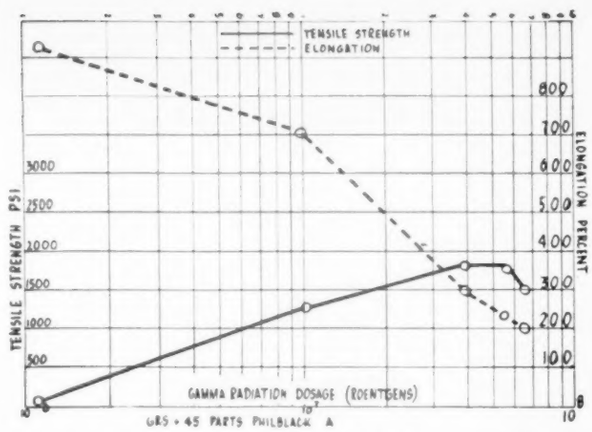

Fig. 7. Effect of gamma radiation on GR-S type rubber/carbon black mixture.

Vulcanization by Gamma Radiation

During the course of studies on radiation damage, one of the engineers in the Materials Laboratory at WADC was plagued by a particularly difficult-to-vulcanize experimental elastomer, and the idea occurred to him that atomic radiation might affect a satisfactory cure and eliminate the blistering and degradation accompanying high-temperature press cures. The uncompounded polymer was subjected to gamma radiation in the Materials Laboratory Cobalt 60 source, and the excellence of the results spawned the entire new project—"The Vulcanization of Rubber by Gamma Radiation." This project is a continuing one at WADC and has been augmented by additional radiation exposures in the much larger radiation source made available at The Atomic Energy Commission materials test reactor in Idaho.

A fairly broad group of both commercial and experimental elastomers has by now received some study, and, although the work is really just started, a number of very interesting facts have been uncovered. Among those which have, to date, received the most attention are natural, GR-S, neoprene, and nitrile type rubbers.

Figures 6-9 show a representative result of gamma radiation on each of these elastomers. Carbon black as Philblack A [5] was incorporated in each polymer, but no other compounding ingredients of any kind were used. Several increasing radiation dosages were used ranging from 1 x 10^7 to 10^8 Roentgens. Generally, 1 x 10^7 Roentgens seems to represent more or less the threshold of vulcanization. It is also important to note that at no time were any of the samples exposed to greater than ambient temperature, nor were any chemical vulcanizing agents used.

Figue 6 shows a natural rubber—Philblack A compound. It appears that somewhere between 2 and 4 x 10^7 Roentgens is about right for this compound.

Figure 7 shows a similar GR-S type of compound. The ideal radiation dosage for this compound is less well defined, but appears to be between 1 and 4 x 10^7 Roentgens. Again incipient vulcanization is about 1 x 10^7.

Figure 8 is a nitrile rubber compound of high nitrile content. This sample shows a definite peak between 2 and 3 x 10^7 Roentgens, and incipient vulcanization is less well defined than in the two previous figures. The physical properties, however, are appreciably better than those for some of the other samples exposed to gamma radiation.

Figure 9 is a Neoprene WRT compound. This type of rubber appears to be highly reactive to lower radiation dosages, but, nevertheless, exhibits the plateau-like curves to a greater degree, a phenomenon worthy of further study.

It should be pointed out that no attempt has yet been made to develop optimum or maximum physical properties in these rubbers. There is no evidence so far brought forth, though, to indicate that the properties of chemically vulcanized rubber cannot be equaled or at least approached and perhaps exceeded by rubber vulcanized by gamma radiation. Indeed, some very brief checks have so far indicated that compression set can be made to approximate that of the best low-set chemical vulcanizates; air aging is equal to most or perhaps somewhat better; and plasticizer extractability seems to have been inhibited noticeably; this latter factor obviously is of interest to the Air Force.

One very favorable factor is that since there is absolutely no residual radioactivity and no active chemicals are present in the gamma vulcanizate, compounds with very greatly reduced toxicity can be made, a factor of some importance to many rubber products. The results of this work are reported in WADC TR 55-57.[6]

Results from Polymer Research

Turning now, to the field of polymer research, and permitting one's imagination a free rein, a horizon of virtually limitless extent is unfolded. Although much very fine work has been accomplished in this field, it takes only a brief acquaintance to convince one that the surface has only been scratched. We are at the moment confronted, perhaps, with a locked door which needs only a key to be opened.

Poly FBA Elastomer

Considering experimental materials which have advanced more or less to the pilot stage, two in particular have shown much promise as interim solutions to Air Force problems. The first of these is a material called Poly FBA. It is a very heavily fluorinated acrylic-type rubber, developed by Minnesota Mining under Air Force sponsorship. This material is perhaps unique in its chemical resistance and has the additional advantage of heat resistance at least equal to that of the other non-fluorinated acrylic polymers. Although at room temperature it exhibits rather dead, sluggish characteristics, as the temperature goes beyond 200° F., it becomes quite elas-

[5] Phillips Chemical Co., Akron.

[6] Work on other subjects already discussed in this paper is covered in WADC Tech Reports available upon request from Wright Air Development Center, Wright-Patterson Air Force Base, Dayton, Ohio, as follows: TR 54-318 and 54-458 on Rubber for Hydraulics Fluids; TR 53-5 and 54-190 on Rubber for Synthetic Lubricants.

[7] Esso Standard Oil Co., aviation division, New York, N. Y.

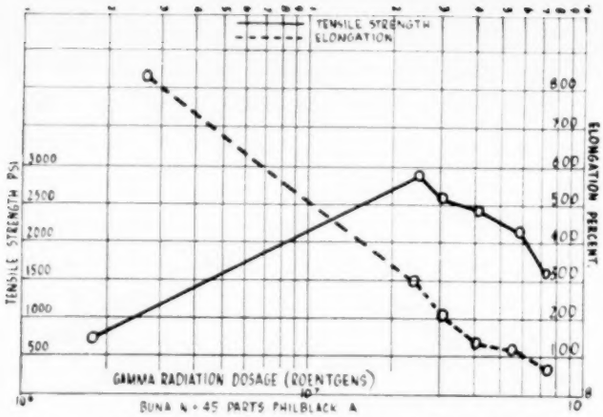

Fig. 8. Effect of gamma radiation on nitrile rubber/carbon black mixture. Note peak between 2 and 3 x 10^7 Roentgens.

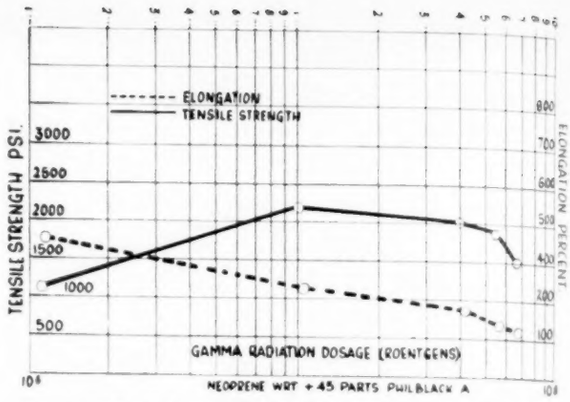

Fig. 9. Effect of gamma radiation on Neoprene WRT/carbon black mixture. Plateau-like curve is of special interest.

tic. This feaure coupled with its excellent resistance to fuels and lubricants, particularly of the diester variety, makes Poly FBA an extremely attractive material. It is also completely resistant to ozone and only moderately degraded by fuming nitric acid. Its low-temperature properties, however, limit its use to about 0 to —10° F.

TABLE 2.
TYPICAL PROPERTIES OF POLY FBA COMPOUND

	Original	Air Aged 70 Hrs. @ 350° F.
Tensile strength, psi.	1100–1300	500–800
Elongation, %	250–400	200–300
Hardness, Shore A	50–70	50–70
Set at break, %	5–15	15–25
Compression Set, ASTM D 395,* Method B—70 hrs. at 250° F. —%		

This polymer can be readily vulcanized through the action of certain amines and is readily processable with conventional techniques. Table 2 shows typical original and air aged properties of the compounded, vulcanized Poly FBA rubber.

Table 3 demonstrates its resistance to a variety of media under conditions which destroy most conventional rubbers in a fraction of the time.

Figure 10 is devoted to the effects of Esso Turbo Oil 15,[7] a diester lubricant conforming to jet-engine lubricant specifications on Poly FBA rubber. For the times and temperatures shown there is no other elastomer known today which can duplicate this performance.

Both laboratory and simulated service tests on Poly FBA rubber have demonstrated not only the expected favorable results in high-temperature service, but some potentialities in high-pressure service not previously suspected.

Since the poor low-temperature properties were recognized at an early date to be unfavorable for Air Force applications, a great effort was made to improve them. A chemical variation was made in the basic structure of the polymer, which resulted in a rubber similar, and equal in all respects, to Poly FBA rubber, but with an added attraction of almost 40° F. lower temperature serviceability.

Kel-F Elastomer

The second of the two materials born as a direct result of military sponsored research is an elastic copolymer of the well-known fluoro plastic Kel-F. It is a development of M. W. Kellogg Co., based on research originally sponsored by the Office of the Quartermaster General, U. S. Army. Known as Kel-F elastomer, this material, also capable of processing by conventional methods, is characterized partly by great strength and outstanding toughness. Its resistance to abrasion appears little short of phenomenal.

Of even greater interest, however, are some of its other properties. As might be expected, hydrocarbon fuels and oils present no problem to Kel-F elastomer. High temperatures and corrosive chemicals, however, offer much greater opportunities for Kel-F really to strut its stuff. Its resistance to high temperatures is exceeded only by silicone rubber, and its resistance to fuming nitric acid is not even approached by any rubbery material known at this time.

* "ASTM Standards for Rubber Products, December 1954," p. 153. American Society for Testing Materials, 1916 Race St., Philadelphia, Pa.

TABLE 3.
EFFECT OF VARIOUS FLUIDS ON POLY FBA RUBBER COMPOUNDS

	JP-4 Fuel 70 Hrs. at 212° F.	Red Fuming Nitric Acid 70 Hrs. at RT	Hydrocarbon Reference Fuel 70/30 Iso-Octane/Toluene 70 Hrs. at 212° F.	Red Fuming Nitric Acid 200 Hrs. at RT + 24 Hrs Rise in Water
Tensile strength, psi.	1070	579	560	1278
Elongation, %	160	514	115	329
Hardness, Shore A	65	—	47	*50
Set at (break), %	—	35	—	20
Volume increase % (approx.)	10	25	28	—

Note: All tensile properties run on dumbbells 1/8-inch wide x approximately 0.040-inch thick pulled at 12 inches per minute.
* Approximate.

TABLE 4.
EFFECT OF VARIOUS MEDIA ON KEL-F ELASTOMER

	Silicate Ester Hydraulic Fluid— 70 Hrs. at 400° F.	70/30 Iso-Octane/Toluene Reference Fuel— 70 Hrs. at Room Temp.	White Fuming Nitric Acid	
			70 Hrs. at R.T.	144 Hrs. at R.T.
Tensile strength, psi	3380	2180	1240	995
Elongation, %	226	510	335	317
Hardness, Shore A	91	72	—	—
Vol. change, %	7.4	23.6	39	—

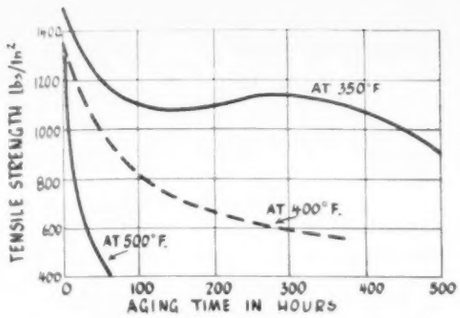

Fig. 10. Retention of tensile strength on aging in Esso Turbo Oil 15 of Poly FBA rubber compound at 350, 400, and 500° F.

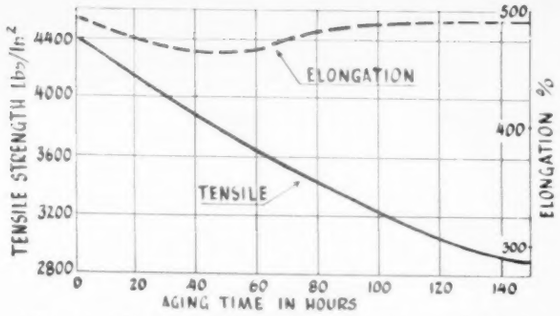

Fig. 11. Effect of air oven aging at 400° F. on Kel-F elastomer compound.

Figure 11 depicts graphically the original and air oven aged properties of a typical Kel-F elastomer compound. It has since been shown that aging at 400° F. for one month is possible without severe loss of properties. Table 4 shows the resistance of Kel-F to several media, including fuming nitric acid. It is obviously a versatile development.

Figure 12 shows the acid permeability resistance of Kel-F elastomer, which is unique among elastomeric materials. It is a natural for use as hose, seals, and protective garments.

On the less favorable side, Kel-F elastomer becomes quite stiff, though not brittle at low temperatures, has so far rather high compression set, and is not resistant to the class of fluids including ketones, diesters, etc. Improvement may be expected, however, as compounding techniques are developed, and its other outstanding properties—including exceptional abrasion resistance—will make Kel-F elastomer a first choice for many new applications.

Air Force Research Program

So much for the present, but what of the future, perhaps ten years hence? Dependence on chance developments may be toying with disaster, whatever may be the problem. Based on some slight experimental evidence, the suggestions and recommendations of the most highly qualified scientists available to us, and to some extent, on pure imagination, a long-range program of both basic and applied research has been organized and activated.

Internal research in the WADC Labs is currently centered on fluorinated acrylamides, and their derivatives and a series of silane polymers and copolymers. Fluorinated silicone polymers have already been prepared and very briefly evaluated. This work is being continued and amplified under contract.

The potentialities of fluorine and fluorocarbon compounds are being further investigated through studies of fluoro-polyesters, polyethers, and other materials.

The well-known thermal stability of the complex metallo-organic group, known as chelates, also offers a possibly fruitful research field, provided, of course, that

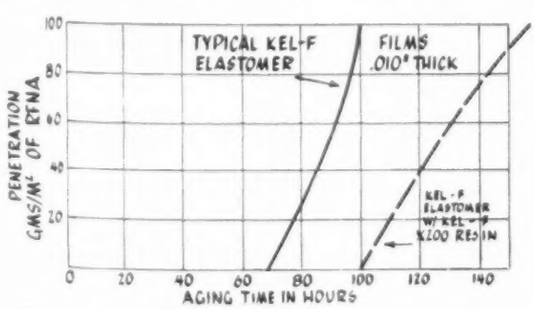

Fig. 12. Permeability of Kel-F elastomer compound to fuming nitric acid.

means can be found to produce more or less rubbery polymers from them.

The potential for the really big payoff lies in the inorganic or semi-organic field. The silicones, as the first and to date only successful development in this field, make further studies extremely attractive. The colossal possibilities inherent in such materials make an all-out effort an absolute must.

Foregoing the many complex details which such a program necessarily entails, it may be mentioned that studies of possibly polymerizable compounds of boron, phosphorus, aluminum, nitrogen, silicon in combination with each other as well as with other elements are being carried out in a search for the truly super rubber, which is vital to the fulfillment of the designers' dreams. Basic experiments have shown that the discovery of such a rubber is no more fantastic than many miracles already accomplished and accepted as commonplace today. The military services are fortunate in having acquired the services of research staffs of some exceptionally competent organizations, including the University of Southern California, Rutgers University, the National Bureau of Standards, The B. F. Goodrich Co., Brooklyn Polytechnic Institute, and others in carrying out early phases of this program which may some day result in the development of one or more rubbery polymers functional between perhaps —130 and 700-1,000° F. and which will be relatively unaffected by almost any solid, liquid, or gaseous environment.

A few words from a recent report by General Nathan Twining to the Congress are particularly relevant to this program.

Quoting General Twining—"The quality of our equipment is dependent on our Research and Development efforts. The Research and Development programs we undertake during the forthcoming year will determine the effectiveness of our weapons in six, eight, or ten years' time." And again—"The qualitative battle of any World War III is being fought right now in our laboratories. Whether we like it or not, we are in a technological race that we cannot afford to lose."

Summary and Conclusions

In a very brief summary it may be said that the past decade has seen tremendous advances in aeronautical science and technology, which in turn have posed heretofore undreamed of problems for the materials engineer. Much work has been undertaken, and some success has been realized. The ratio of problems remaining to problems solved, however, is so great that truly heroic achievement is urgently needed.

One last word—General Twining's reference to "our laboratories" necessarily includes, with the military laboratories, those of our universities, the professional research organizations, and particularly the laboratories of the entire American industry, without which—nothing!

A. F. C. A. CHAPTER ACTIVITIES

ARMY CHEMICAL CENTER, MD.

The Army Chemical Center Chapter's annual election was held October 19. Dr. Floyd Odell of the Medical Laboratories was elected president; Mr. Arthur W. Talbott, Chemical and Radiological Laboratories, vice president; and Mr. Randolph Munro, Chemical and Radiological Laboratories, secretary-treasurer. Directors elected for the forthcoming year were Mr. E. H. Schwanke, Chemical and Radiological Laboratories; Dr. W. H. Summerson, Medical Laboratories; and Dr. C. B. Marquand, Executive Director, Chemical Corps Advisory Council.

Dr. Odell, the new president, has a B.A. degree from Linfield College and Ph.D. in biology from Yale. He served during World War II with the U. S. Army Air Forces and joined the Medical Laboratories at the Army Chemical Center in 1946, where he is now Assistant Chief of the Biophysics Division. He is a native of the State of Oregon.

CLEVELAND

President R. A. Lawson of the Cleveland Chapter has announced that the chapter has presented a check for $500.00 to the Case Institute of Technology, providing a scholarship of $250.00 a year for two years to be awarded an undergraduate in chemistry or chemical engineering on the basis of academic record and financial need.

FORT McCLELLAN

Fort McClellan Chapter started the new fiscal year with a membership drive which netted the highest total in several years. The campaign was conducted under the leadership of Col. C. H. Wood, Chapter President, and Lt. Col. Truett K. Grant, Membership Chairman.

Chapter dinner meetings are scheduled to be held monthly at the Fort McClellan Officers Club. The programs arranged under the direction of Mr. Marshall Hunter, of Anniston, Program Chairman, are varied so as to include both serious discussion and light entertainment.

A special attempt has been made to increase the membership from outstanding business men and civic leaders in the surrounding area. Also, emphasis has been placed on a program that will be of interest to the feminine contingent. Both objectives have been realized.

The opening meeting in October was largely given over to a clever performance of magic by Mr. Dan C. Anderson, amateur magician of Birmingham.

A resume of some of the outstanding advances in science during the last 50 years and a picture of possible future developments were given at the November meeting by Dr. Houston Cole, President of Jacksonville State College, who spoke on "Man In Action."

At the November meeting, President Wood presented A.F.C.A. plaques to Lt. Col. Truett K. Grant and Mr. Irvin R. Clark for meritorious service. Col. Geo. W. Dorn, immediate past president, and Lt. Col. Edmundo Escudero, outgoing secretary-treasurer, both of whom are former plaque winners, were awarded Chapter citations for additional meritorious service during 1955.

NEW ENGLAND

While intensely engaged with its preparatory work for the forthcoming A.F.C.A. annual meeting in Boston on June 14-15, New England Chapter found time last fall to organize a visit to Eglin Air Force Base, Florida, commanded by Major General Edward P. Mechling. Twenty-five members of the chapter, representing a variety of industries, proceeded to the Air Force armament center and witnessed a fire power demonstration there on October 11. The trip was made in a C-131 aircraft.

Mr. Harry A. Wansker, Director of Government Relations, United-Carr Fastener Corporation, and vice president of A.F.C.A. for meetings, sent a letter of appreciation to General N. F. Twining, Chief of Staff, U. S. Air Force.

NEW YORK

Mr. S. Askin, president of the Heyden Chemical Corporation was reelected president of the New York Chapter of the A.F.C.A. at the chapter's annual dinner meeting held at the Hotel Delmonico on November 3. Mr. Jacob K. Javits, Attorney General of the State of New York, the guest speaker, urged greater use of American business in support of our foreign policy and suggested various ways in which such assistance might be rendered.

Several hundred members and guests, including a number of Chemical Corps officers from out of the city, attended. In the group pictured above just before the dinner are, left to right: Col. Selig Levitan, Col. Harold Walmsley, Brig. General Clifford L. Sayre, Brig. General Marshall Stubbs, Mr. Javits, Brig. General William R. Currie, and Lt. Colonel Gregory P. Villaflor.

PURDUE

The Purdue Chapter of A.F.C.A. has had two meetings since school began in September.

The first meeting was highlighted with a talk by Professor Herschel Hunt, noted physical chemist at Purdue. His talk was concerned with the heats of combustion of explosive agents and proved to be extremely interesting.

During the second meeting, the film, "Atomic Support For the Soldier," was shown. Major William C. Lafield, Jr., R.O.T.C. instructor at Purdue, presented the president of the chapter, Manuel Sanches, the Armed Forces Chemical Association's plaque for meritorious service.

During the coming months of the present school year the chapter plans to have meetings twice a month. Field trips to various military and industrial establishments in Indiana are being planned.

SAN FRANCISCO

Military aspects of the utilization of technical manpower was the subject of a panel discussion at the dinner meeting of the San Francisco Chapter, held at the Officers' Mess at the Presidio of San Francisco on November 17.

In the picture above, snapped during the cocktail hour preceding the dinner, are three of the panelists: Dr. Joel Hildebrand, president of the American Chemical Society; Brig. General Marshall Stubbs; and Mr. Donald Krotz, assistant to the president of California Research Corporation.

WASHINGTON, D.C.

At a luncheon meeting at the All State Hotel on November 28, Mr. L. Douglas Weiford, Washington representative of the Stauffer Chemical Company, was unanimously elected president for the ensuing year. Maj. Charles E. Pledger, Jr., Washington attorney, and Col. Robert T. Norman, of Auchinloss, Parker & Redpath, Investments, were made vice presidents and Mr. Herbert R. Miller of Olin-Mathieson Chemical Company was elected secretary-treasurer. Dr. W. T. Read, retiring president, presided. Admiral Prime, A.F.C.A. president, addressed the meeting on problems of promoting interest of young people in scientific studies.

WILMINGTON

The Wilmington Chapter of A.F.C.A. held its annual meeting November 20, the guest speaker being Mr. George R. Gallagher, General Counsel, Subversive Activities Control Board.

Officers of the chapter for the forthcoming year were elected as follows: President, Mr. A. L. Churchill, Atlas Powder Company; 1st vice president, Mr. Ford H. McBerty, Engineering Department, DuPont Company; 2nd vice president, Mr. Henry T. Clark, Atlas Powder Company; and secretary-treasurer, Dr. Robert T. Hall, Hercules Powder Company.

HOOKER

(Continued from page 27)

Niagara Alkali, which is now a division of the Hooker Company, is the oldest, most experienced producer of caustic potash and potassium carbonate in this country. It sells these and other chemical products to over 500 customers in more than 30 industries, which together comprise a broad cross-section of the American economy.

Today, the Hooker Electrochemical Company has four chlor-alkali plants and another under construction, two chlorinated solvent plants, two phenolic resin plants, a wood flour plant, and a subsidiary sales firm in New England. It produces hundreds of chemical products which it distributes to virtually every important industry in the country—a far cry from that tiny, muddy, chlorine-saturated plant which began operations in a pear orchard just 50 years ago. Hooker's established chemicals plus Hetron resins, new fluorine compounds and the vast new outlets opened by the union with Durez Plastics & Chemicals, Inc. and the Niagara Alkali Company foretell a future for Hooker even brighter than its past.

SELECTIVE SERVICE

(Continued from page 33)

cluding some very important people, or including a great many whose chief claim to specialization is the special interest someone has in them. We have witnessed the less than satisfactory, if not futile, efforts also of experts.

IN SELECTIVE SERVICE, we are unshaken advocates of *selective* manpower procurement, i.e., procurement under a system wherein the question as to military service is not *whether* the young man has the obligation to perform it but *when* he is to perform it. The decision can be left to him only to the extent which the National security permits.

Citing this position develops a fact, not mentioned often enough about Selective Service, which is that *deferment in the National interest is a responsibility ranking equally with induction into the Armed Forces.* There are people still connected with the System who properly could consider themselves the original promoters of the deferment concept as opposed to exemption, and the difference is highly important.

This System supports completely the idea that "specialized" personnel should be trained and utilized, but National Defense should be neither over-worked as the reason for it nor used as an excuse for not going out to the direct defense of the Nation which has given and protected the opportunity to become "specialized." Both training and utilization should be better than they ever have been heretofore, but this should be brought about in some better way than by implanting the idea that some civilian activity is going to become an *exemption from* or *something in lieu of* military service.

All young men should get all the training and preparation they can to equip themselves to be the best kind of citizens all of the time and to be the best kind of soldiers for whatever part of their time they might have to serve in that way.

More good ways of getting this done are being provided young Americans today than ever before. No employer should fail to inform himself and no young man should fail to examine carefully the obligations and prospects of military service—and the provisions of the Armed Forces Reserve Act of 1955 for meeting these obligations and for preparing against a day of greater emergency.

MISCELLANY

ARMY MATHEMATICS CENTER TO UNIVERSITY OF WISCONSIN

Plans to award the University of Wisconsin a contract for the establishment and operation of a Mathematics Research Center to conduct research and investigations in mathematics and high speed computation theory were announced on Nov. 16 by the Department of the Army.

The Center is to provide a nucleus of highly qualified mathematicians who will carry on investigations in mathematics of interest to the Army and who can be called upon for advice on specific problems beyond the capability of Army facilities.

The Center will employ a resident staff under the direction of Dr. R. E. Langer, Professor of Mathematics, and will be equipped with a large-scale high-speed computer facility.

The announcement states it is expected this Center will provide the mathematics complement to the support of long range research intended to produce major capability improvements and inspire confidence in new approaches and ingenious applications of new ideas.

MR. HENRY N. MARSH HONORED

Mr. Henry N. Marsh, Deputy Assistant Secretary of the Army (Logistics), was presented the Department of Defense Certificate of Appreciation by Secretary of the Army Wilber M. Brucker during ceremonies at the Pentagon on Oct. 17, 1955.

The award, highest Department of Defense civilian award, was made for outstanding services rendered to the Department of Defense in the field of engineering and production of propellant powders and explosives.

Mr. Marsh is a past president of the Wilmington Chapter of A.F.C.A. He served as consultant to the Assistant Secretary of Defense (International Security Affairs) from September to December, 1950, and at various times on special task forces inspecting propellant and explosive production facilities in NATO countries.

Mr. March (left) receiving award from Secretary Brucker.

MILLER COMMITTEE REPORT APPROVED

Secretary of the Army Wilber M. Brucker on Nov. 6, 1955, approved implementation of a report made by an ad hoc civilian committee on the administration and organization of the Army Chemical Corps.

The major recommendations of the Committee are (1) to appoint an Assistant Chief Chemical Officer in charge of long-range planning and doctrine; and (2) the establishment of three separate commands for Research and Development, Engineering, and Materiel.

The Committee, which was appointed by Major General William M. Creasy, Chief Chemical Officer, consisted of Mr. Otto N. Miller, vice president of Standard Oil Company of California, Chairman; Mr. Hans A. Klagsbrunn, senior member of the Washington, D. C. law firm of Klagsbrunn, Hanes, and Irwin; Dr. James A. Shannon, director, National Institutes of Health, U. S. Public Health Service; and Mr. George H. Watkins, vice president, University of Chicago, and Dean of the Business Management School.

The report was reviewed and its approval recommended by Mr. George W. Merck, Chairman of the Board, Merck & Company, in his capacity as Chairman, Technical Advisory Panel on Biological and Chemical Warfare, Office, Assistant Secretary of Defense (Research and Development).

INDUSTRY DEFENSE COURSE

A special course in industry defense, the first to be offered by the Federal Civil Defense Administration, has been established at the agency's Staff College in Battle Creek, Michigan. More than 65 representatives of management, labor and governmental agencies that work with industry were expected for the first five-day course, which opened on November 28.

FCDA RADIOLOGICAL DEFENSE DIVISION

The Federal Civil Defense Administration has announced the establishment of a separate Radiological Defense Division to assist in developing national preparedness against radioactive fallout resulting from a nuclear attack.

Jack C. Greene, 34, a graduate electrical engineer of the Massachusetts Institute of Technology and Assistant Chief of the Atomic Energy Commission Radiation Instruments Branch before joining FCDA in 1951, will serve as acting director of the new division.

The division will be responsible for research in radiological defense, an instrumentation program for radiation detection and analysis and a nationwide training program for civil defense units.

CIVIL DEFENSE HELICOPTERS

The Federal Civil Defense Administration, in recognition of the important defense role of the helicopter, has offered to help interested units in the field to purchase rotary-wing aircraft of this type for training and use in emergencies caused by natural disaster or enemy attack.

FCDA announced helicopters may be purchased by territorial, state and local civil defense units under the federal matching funds program.

Details on the procedures to follow in applying for federal funds for the purchase of civil defense equipment are contained in a new Chapter 13 of the FCDA Federal Contributions Manual.

CONFERENCE FOR INDUSTRY ON ARMY PROCUREMENT

Through informal arrangements made by armed forces technical service associations a conference on Army procurement procedures, attended by some 200 representatives of industry, was held at the Pentagon, Washington, D.C., on November 17. The Honorable Frank H. Higgins, Assistant Secretary of the Army (Logistics) presided.

Flanked by a panel of four top experts on Army procurement which included two general officers, Mr. Higgins, acting in the role of moderator in the three-hour session, dealt with the many questions placed from the audience. The procedure was a condensed version of six-hour conferences covering the same subject matter conducted by Mr. Higgins with the same panel in ten cities of the country during the period from April through October 1955. These meetings, however, were essentially for procurement district personnel of the Army. The subjects dealt with were: Directives, Types of Contracts, Unauthorized Use of Government-owned Facilities, Pre-award Matters, Army Relations with Contracting Officers, Small Business, The Mobilization Base, and Price Re-determination and Profit.

In view of the interest shown in the Pentagon meeting with industry, plans are under consideration by various technical service organizations with a view to requesting Mr. Higgins to conduct a new series of similar programs in designated cities, these meetings to be sponsored individually by the various technical service organizations.

CIVIL SERVICE HONOR FOR MR. LESTER J. CONKLING

Mr. Lester J. Conkling, chemical engineer of the Chemical Corps with a record of 35 years service at the Army Chemical Center, Maryland, is one of 10 career employees of the Government who recently received the Civil Service Award for exemplifying in an outstanding manner the primary characteristics of career service through competence, efficiency, character and continuity. The award was presented at a dinner at the Sheraton-Park Hotel in Washington, D.C. on December 2 under the auspices of the National Civil Service League, a nonpartisan citizens organization which seeks through the award program to enhance the prestige of the public service. Winners were selected from 100 nominations submitted by 33 different government agencies.

Former Governor of New York, Thomas E. Dewey, and Senator Olin D. Johnston (D., S.C.) addressed the gathering of approximately 1,000 persons gathered to pay tribute to the 10 honored federal employees.

Mr. Conkling, following military service in World War I, became an associate chemist at the Edgewood Arsenal in March 1921, since which time he has served continuously at that station. His present post is Chief, Production Branch, Edgewood Arsenal. He is the author of many technical reports and has received the Civilian Service Award and the Military and Exceptional Service Awards presented by the Government. He was born on November 24, 1891, at Middletown, New York and holds an A.B. degree in chemistry from Cornell University. He is a charter member of the A.F.C.A., was president of the Army Chemical Center Chapter in 1952, and has served on the Board of Directors.

DEPUTY CHIEF CHEMICAL OFFICER

Colonel William E. R. Sullivan, whose appointment as Deputy Chief Chemical Officer, Chemical Corps, was recently announced by the Department of the Army, was born in Boston, Mass., and is a graduate in chemical engineering of Northeastern University of that city. He also is a graduate of the Army Engineer Field Officers Course, Command and General Staff College, the Industrial College of the Armed Forces, and the Harvard University Graduate School of Business Administration.

Col. Sullivan's military experience dates from 1935 when he was a lieutenant in the Corps of Engineers, Officers Reserve Corps. He later served with the Massachusetts National Guard from which he entered the Army in 1942, with the rank of Captain. He went overseas in 1944 as commanding officer of the 251st Engineer Combat Battalion, which he had activated and trained. His unit served in Normandy, Belgium, Holland, Luxembourg, and Germany and received a Presidential Citation for outstanding gallantry duuring the assault crossing of the Roer River.

In 1945, Col. Sullivan was assigned to Austria and placed in charge of restoring Austrian railroads, gas, electric and water systems, and the rebuilding of Austria's highway network. Returning to the United States in August 1946, he was commissioned in the Regular Army, and transferred from the Engineers Corps to the Chemical Corps.

THE HISTORICAL CORNER

By Brooks E. Kleber*

Tragedy at Cerasuolo

The chemical mortar battalion—armed with the splendid and versatile 4.2-inch mortar—probably gave the Chemical Warfare Service as much World War II recognition as any unit or activity. The fact that the Chemical Corps' connection with the unit and weapon has been terminated, does nothing to detract from the glory won by the chemical mortar battalions in World War II. The following episode from the wartime experience of the 3d Battalion demonstrates that this glory was not won cheaply.

The 4.2-inch mortar made its battle debut in Sicily in the summer of 1943, and the 3d Chemical Battalion, Motorized (a later T/O&E changed the name to chemical mortar battalion) was one of three such units which participated in that campaign. Then came the slow Allied advance up the boot of Italy, the muddiest, hilliest, and perhaps most unpublicized campaign of the war. The mobile chemical mortar with its high trajectory fire was ideally suited for fighting in such terrain; and, altogether, six mortar battalions supported Fifth Army operations in Italy.

In January 1944 the 3d Battalion was supporting a division of the French Expeditionary Corps, on Fifth Army's right flank, in attacks against the formidable Gustav Line. Lt. Col. Edgar D. Stark, the battalion commander, to insure the necessary close support and fire co-ordination for the initial attack, directed his unit's operations from C Company's command post, located in the town of Cerasuolo. On 12 January Colonel Stark held an impromptu meeting at the CP attended by seven officers and a number of enlisted men. At approximately 1448 hrs. German planes attacked the town. At least one bomb hit the command post, killing Colonel Stark, five other officers, and seven enlisted men. The seventh officer, Capt. John G. Hoffman, Jr., left the meeting several minutes before the air raid. Now a lieutenant colonel, Hoffman is on duty in Italy.

Despite this severe blow the battalion was able to continue its mission; within two hours C Company fired 157 rounds. On the following day, however, the battalion reverted to Fifth Army control and was sent to a rest area near Naples.

NEW LIFE MEMBER

Colonel Fred Carp, Chemical Corps (Ret.), 209 S. Fern Street, Wichita, Kansas, recently became one of the Life Members of this Association.

A letter expressing the appreciation of the Association has been sent to Colonel Carp by Secretary-Treasurer O. E. Roberts, Jr.

* Member of the Historical Office, Office of the Chief Chemical Officer, U. S. Army.

COL. WILLIAMSON RECEIVES CROSS OF LEGION OF HONOR

Colonel William E. Williamson, now on duty with the Chemical Corps Board, and who served as Assistant Army Attaché, U. S. Embassy, Paris, from September 1951 to October 1954, has been awarded the Cross of Chevalier of the Legion of Honor by the French Government.

The decoration in honor of his Embassy service was given to Col. Williamson at a reception at the home of the French Military Attaché for Scientific Affairs, Brigadier General Pierre Brison, in Washington, D. C. on November 18. The medal and scroll were presented by General P. M. Bergeron, President of the French Defense Ministry's Scientific Action Committee.

In the group present to congratulate Colonel Williamson—mostly senior officers—were two first lieutenants of the Corps of Engineers. They were Colonel Williamson's twin sons, W. E. Williamson, Jr., and R. E. Williamson, now on duty in the Washington area following service in Korea.

Colonel Williamson, a chemical engineer, served in World War II in the Asiatic-Pacific Theater and later in the Office of the Chief Chemical Officer of the Army in Washington as head of the Intelligence Branch before his assignment to duty in Paris.

COL. MAGNESS IS NAMED MDW CHEMICAL OFFICER

Colonel Thomas H. Magness, Jr., has been named Chemical Officer of the Military District of Washington replacing Lt. Col. A. M. Frey who was assigned as Deputy G-4 (Logistics) on the MDW staff.

A veteran of 19 years service, Col. Magness has an engineering degree from Johns Hopkins University. During World War II he served in the Headquarters of the European Theater of Operations and during the Korean conflict he served as G-4 of IX Corps.

Col. Magness' decorations include the Legion of Merit with Oak Leaf Cluster, the Bronze Star Medal, and the Army Commendation Ribbon. For his Korean service he also received The Republic of Korea's Ulchi Distinguished Military Service Medal.

MR. J. CARL BODE

Mr. J. Carl Bode, 53, president of National Carbide Company, a division of Air Reduction Company, Inc., died November 11, 1955, at the Manhasset Medical Hospital in Manhasset, New York. Mr. Bode resided at Port Washington, N. Y.

Well known in the welding and chemical industries, Mr. Bode joined the National Carbide Company in 1928; he was appointed assistant operating manager in 1946, a year later became operating manager, and in 1948 was elected president. A graduate of the University of Wisconsin, Mr. Bode had been president of the International Acetylene Association since March 1955.